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TECHNOLOGY, NUTRITION, AND THE AMERICAN FOOD SUPPLY

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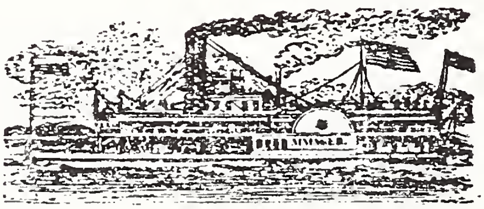
FOREWORD

The population explosion in developing countries is one of the major challenges facing today's world leaders. With the spectre of food shortages as a present reality, some forecasters advocate an immediate increase in agricultural productivity by the United States and other leading food-producing nations in order to fend off a global food crisis. Continued support from the private and public sectors of the American economy for food and agricultural technology and research as well as for relevant information on food and nutrition should assist the many individuals and organizations involved in efforts to deal effectively with the challenges of world food and agricultural needs.

This particular issue of the *Journal of NAL Associates* brings together an interesting and informative group of papers and research material which highlight some of the achievements and problems involved in the development of the American food and fiber system.

Once again, I compliment the editorial staff of the Associates of NAL for developing another pertinent issue.

Richard A. Farley
Administrator for
the Technical Information Systems



INTRODUCTION

Farming and food are so closely intertwined and so mutually interdependent that one might assume that every American recognized the connection. Unfortunately, this is not true. Consumers much too often assume that all farmers must be rich. Some even believe that farming is mainly conducted by large conglomerate corporations interested only in profiting at the expense of the ordinary person. Conversely, some farmers believe that consumers are totally uninterested in the welfare of those who produce the food that they eat and are always calling for lower prices. Indeed, some farm leaders have accused the Federal government, particularly the Department of Agriculture, of being devoted to a policy of "cheap food."

There are still other views. At a recent meeting of a State Academy of Science, a chemist said that research in improving farm production and the quality of food was wasted. Instead, given the present state of the arts in industrial chemistry, all research money should be devoted to transforming "biomass" or green vegetation of any and all types into food forms that would meet nutritional needs and that would be acceptable to the consumer. The chemist asserted that this is the best way to meet the needs of an ever-increasing world population. Perhaps the often referred to "nutritional pill," produced in a chemical plant, is the shape of the future.

Yet the story of agriculture and food in the United States is one of success. At the time of the American Revolution over 90 out of every 100 workers were striving to supply the food and fiber needed in the new nation, with a small surplus for export. Today, only three out of every 100 workers are needed to supply necessary farm products to Americans, with a substantial surplus for export that helps pay for our imports and relieves suffering in disaster areas throughout the world.

We have a plentiful supply of nutritious food, produced largely by family farmers who are protected against natural and economic disaster by a complex series of laws. At the same time, this food costs the consumer about 18 percent of that person's or family's take-home pay--the lowest percentage of virtually any nation in the world.

If we are to continue to enjoy this abundance of wholesome food at a reasonable cost, produced by efficient farmers who are protected against disastrous price declines and natural disaster, we must be alert to the needs and problems of both farmers and consumers. This issue of the *Journal of NAL Associates* is devoted to some of these needs and problems with particular emphasis upon human nutrition.

The issue opens with an historical overview by Alan Fusonie of changes in American agriculture and their impacts upon our food supply. The author concludes that the nation is entering a new era in the development of its food supply--one requiring the shared commitment from all those involved in the food and fiber system and the continued innovative support of science, technology, and the American people.

Food products must be moved from the farm to the processor and then to the consumer. Changes in the agricultural transportation system is the subject of the second article by Douglas Bowers. Again, the author ends with a word of warning. The system is adequate to meet today's needs but the future is cloudy.

The third article, by Terry Sharrer, moves to food technology--the processing of farm products into useable and acceptable forms of food. Although the author mentions such nineteenth century technologies as canning and improved milling practices, he emphasizes such twentieth century developments as drying, freezing, and packaging.

It is sometimes argued that food technology is unconcerned with nutrition. Certainly, as Harry Day in the fourth article shows, faddism and quackery have been and are still with us so far as our nutritional needs are concerned. However, the twentieth century has seen great advances in the science of nutrition and many of these advances have been applied as far as our eating habits are concerned.

The article from the scientific viewpoint is followed by Naomi Aronson's article on the social factors in the development of nutrition studies. A number of problems have impeded the development and fruitful use of nutritional research. The most important was the emphasis upon practical applications, including notions of mechanical and cost efficiency. Too, the traditional divisions between medicine and nutrition slowed both the work on vitamins and its dissemination. Today practical economic considerations continue to outweigh basic research on the role of nutrition in achieving optimal health among the people of the United States and the world.

The five articles mentioned above survey some of the problems related to the interactions of agriculture, food, and nutrition. The authors point out that many related problems need research and study and that those discussed need greater study in depth. The last two papers making up this special issue make substantial contributions to future research. The first, by Robyn Frank, is a comprehensive review of available information resources for the study of food science and human nutrition. This paper is followed by a bibliography compiled by Gloria Billick listing some 400 references on the history of human nutrition in America, 1600 to 1980.

It is the hope of the editors and of the authors of these articles on agriculture, food, and nutrition that they will encourage further research in the relationships between these subjects. Just as importantly, they hope that they will contribute to the further development of a rational national policy on agriculture, food, and nutrition.

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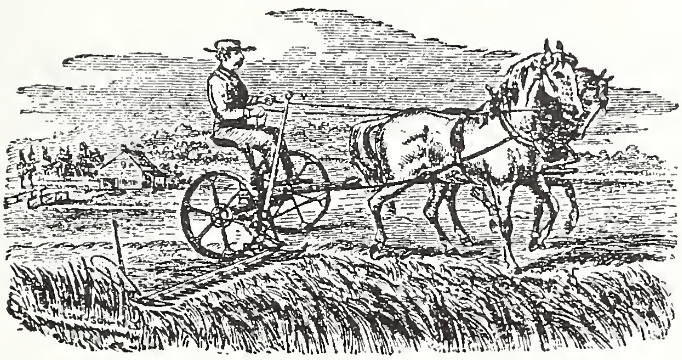

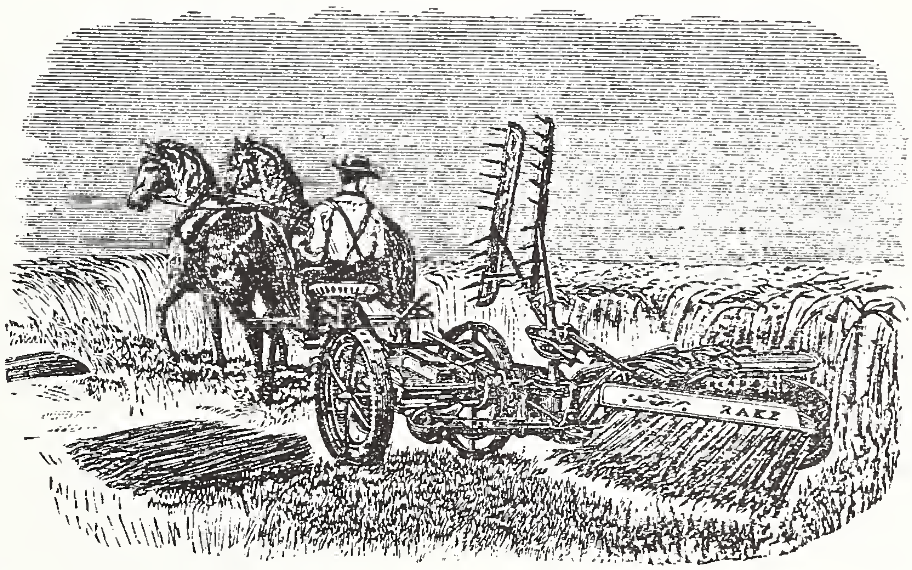

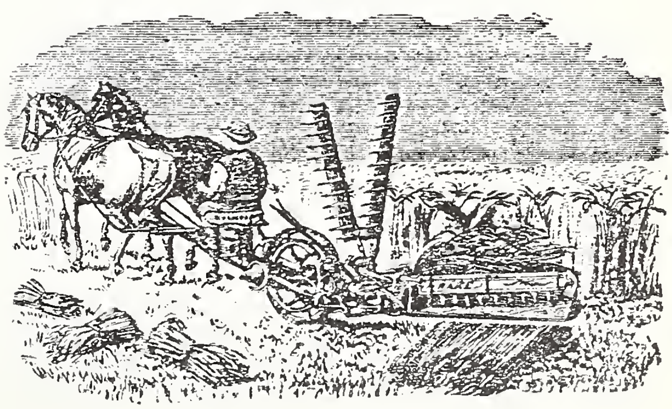

("The New Champion Mowing Machine," top illustration; "The New Champion Reaper," bottom illustration; "The Champion Combined Mower and Reaper," middle, as found in *American Agriculturist*, October, 1879).

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THE DEVELOPMENT OF THE AMERICAN FOOD SUPPLY: A SELECTIVE HISTORICAL OVERVIEW

BY

ALAN E. FUSONIE*

Since the beginning of time, man has functioned as part of a collectional economy in which he fished, hunted, and gathered food provided him by nature.[1] About 10,000 years ago, man's improvident existence of hunter-gatherer began to change with the inclusion of food-producing activities. With improvements in the domestication of animals and plants, early man became less dependent upon wild food sources to supplement his diet. What emerged was both a clear division of labor between pastoral and vegetable-grain agriculture and a man who had learned to utilize and develop more effectively the plants and animals around him. In doing so, he increased his options for basic survival.[2]

Several centuries before the arrival of Columbus in the New World, the first Americans--Mayas, Aztecs, Chibchas, Incas--were involved in the development of a food supply. In particular, the Aztecs in Mexico lived off a diet of maize (corn), beans, tomatoes, and capsicum peppers; the Incas in Peru subsisted on a diet that was primarily vegetarian in nature although fish and wild game served as occasional luxuries. A basic cornerstone of the Inca's food supply was the system of irrigation canals, a vital necessity essential to the productive increase in corn acreage; without this irrigation system corn, as a basic dietary staple, would have ceased to flourish.[3] This innovative culture also provided for the basic welfare of its people by means of a reserve system for the storage and distribution of both food and clothing.

The Spanish colonization process in the New World included some agricultural measures which, to varying degrees, may have had a positive influence on the growth of the food supply. With the discovery of the New World by Christopher Columbus, there developed a limited traffic of foodstuffs between the Old World and the New. On a later voyage to the New World, Columbus brought with him seeds, wheat, chickpeas, and sugar cane.[4] By the end of the 15th century the Spanish had introduced their agricultural system to the Indies establishing the forbearers of many of the domesticated animals, plants, and seeds in existence there today. Among these should be mentioned cattle, horses, vineyards, and wheat which were reportedly brought to Peru by Pizarro as well as irrigation methods, windmills, agricultural implements, and processing practices that were also brought to the New World by the Spanish.[5]

Around 1500, it has been estimated that 840,000 Indians were living in what is now the United States. These Indian people were either agriculturists or semi-agriculturists--that is to say, while some lived almost entirely on agriculture, others combined hunting and gathering with farming and fishing. From the eastern seaboard, to the arid Southwest and Great Basin, to the northern part of the Pacific Coast and Alaska, the environment and/or geographical differences played critical roles in the development of food supply among the many different Indian tribes.[6]

The British View of Food Resources in North America

Throughout the fifteenth and sixteenth centuries, European expansion and efforts at colonial settlement in the New World continued. Across the Atlantic, after the war between England and Spain had ended in 1604, many English gentry and merchants increased their interest and investments in the colonizing of the New World.[7] Of particular interest to the colonizers were the natural resources of North America which had been positively described and often enlarged upon in some of the early travel reports and correspondence. For example, Thomas Hariot, one of the settlers on the island of Roanoke in 1585, in his book entitled *A Briefe and True Report of the New Found Land of Virginia* first published in 1588, provided not only accounts of Indian agriculture but also descriptions of some of the wild game food supply such as deer, conies, bears, and various types of fowl and fish.[8] The land found from Virginia southward was reported to have a warmer climate than that found in England and, therefore, was looked upon as an ideal region in which to cultivate those crops not able to be tilled in England. The northern coastline was regarded as an area capable of providing farming settlements along European lines.

Food Supply at Jamestown and Plymouth

In December of 1606, the Virginia Company of London sent over its first settlers none of whom were practicing and/or knowledgeable farmers. Landing on the Jamestown peninsula in May, 1607, these potential settlers must have had to develop a food supply as well as to seek food from the Indians in the area in order to sustain themselves.[9] There had been reports both of American abundance and of hardship and suffering so that ". . . anyone who doubted that riches were waiting to be plucked from the [Virginia's] trees had reason to expect that a good deal might be plucked from the people of the land."[10] As it turned out, in 1607 and again in 1622, the Powhaton Indians saved the Virginia settlers from starvation by sharing with them their own supplies of corn, bread, fowl, oysters, and deer. Two Indian captives also showed these settlers how to plant 30 to 40 acres of corn.[11]

By way of contrast, the Pilgrim Fathers who landed at Plymouth in 1620 possessed some limited knowledge about farming. Although lacking working farming experience, they either had acquired useful knowledge as sons of agriculturists or had grown up in one of the agricultural counties in England. Intending to rely initially on the wild game and fish that, reportedly, was in abundance everywhere, these colonists brought with them the basic resources for developing an initial subsistence food supply--seeds, hoes, mattocks, and some barnyard animals including chickens, goats, and pigs. Fortunately, they found friendly Indians already engaged in a form of hill hoeing susbistence agriculture which entailed the cultivation of corn, beans, squash, and pumpkins. Cultivating about two and one-half acres into about 900 hills planted in corn, these Indians could generally produce a food supply of about 45 bushels. In addition to sharing the Indians' food that first winter, the Plymouth settlers were most grateful to learn from the Indian his style of planting and cooking. The utilization of Indian agricultural practices was a critical turning point for the colonizing efforts at both Jamestown and Plymouth for the adoption of the Indian's agricultural plants, cultivation and harvesting methods, and processes of food preparation assured adequate food supplies.[12] By 1625, the Plymouth settlers successfully harvested their own English grains as a cash crop and, eventually, provided surplus food stuffs for both the market created by new settlements and the overseas markets

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such as found in the Azores and the Caribbean.

In New England, a growing spirit of agricultural experimentation and economic ambition was evident. In 1747, after having read the 1731 edition of *Horse-Hoeing Husbandry* by Jethro Tull (1674-1741)--the English agriculturist and inventor--Jared Eliot, clergyman and natural philosopher, conducted his own experiments and recorded his findings in his own 1760 publication entitled *Essays Upon Field-Husbandry in New-England.*

During the first half of the 18th century, individual farmers in Connecticut could be found hard at work creating an agricultural surplus to use as barter for items which they could not provide themselves.[13] From the beginning, the vast majority of settlers were "market-oriented and anxious to improve their lot in life."[14] In time, however, the farmers of New England took stock of the agricultural realities of their situation--the poor soil, uneven terrain, severe climate, and short growing seasons in their part of the country--and weighed them against the lure of available land to the south and west. As a result, many farm-oriented families gave up the rough agricultural environment of New England and migrated southward into New York and Pennsylvania.[15] The farmers who remained in New England, often out of necessity, supplemented their agricultural activities with jobs as carpenters, lumbermen, and tavern keepers.

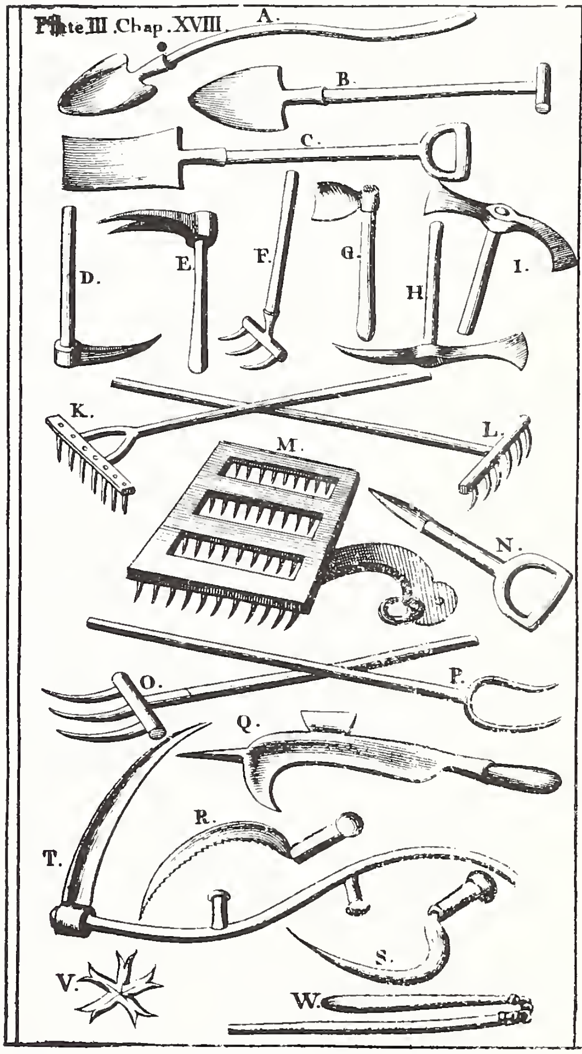
Food Supply in the Middle Colonies

Farmers settling in New Jersey, New York, Pennsylvania, and Delaware found both the soil and the climate more adaptable to the development of an agricultural food supply than they had in New England. The region provided farmers with improved access not only to domestic markets north and south but also to foreign markets. Assuming the role of the major wheat and livestock producers, the Middle Colonies emerged as the major food suppliers. Consequently, by 1775, some of the most advanced flour mill operations in the world were located in Pennsylvania, Delaware, and Maryland. From the beginning, Pennsylvania farmers were producing a surplus of wheat for cash sale. With a viable wheat-oriented export economy, this region became the "bread basket of America."[16] By 1790, in terms of food supply, the land between the Potomac and the Hudson Rivers was the most productive in the colonies particularly in the area of cereal crops.[17]

From the establishment of Jamestown to the signing of the Declaration of Independence, the colonies had undergone an evolutionary process beginning with the lure of abundant land and continuing through the quest for survival and adjustment to the environment. To the farmer, progress in creating a food supply was measured by the amount of back breaking work undertaken especially in the forested regions where it took about one year to clear three acres of wooded land and about 10 to 15 years to develop a commercial type of farm operation. The length of time taken to clear the land can be attributed in part to the fact that the work was undertaken with rather primitive tools.

Around the time of the American Revolution, many New England farmers were cultivating the land with an ox-drawn plow, sowing the grain by hand, reaping the crop with a sickle, and threshing it with a flail. For many, during this period, farm labor was a matter of drudgery.[18] Some outstanding American agriculturists of the time such as John Beale Bordley, Metcalf Bowler, Samuel Deane, Thomas Jefferson, George Morgan, Richard Peters, Timothy Pickering, John Spurrier, George Washington, and others were aware of the need for improvements in both field implements and farming practices. These more affluent and articulate agriculturists were engaged constantly in experimentation, often communicating their findings to each other while, at the same time, keeping abreast of the latest developments occurring abroad.[19] In particular, there was a need to remain aware of agricultural developments in England for British agriculture had entered a period marked by substantial activity and improvements particularly in the areas of agricultural machinery, methods of cultivation, and stockbreeding.

By 1790, a major portion of the new nation's population could claim America as their birthplace; numbering about four million, 90 percent of them were farmers and they occupied the area from Maine through Georgia. The early foundations and/or justifications for additional new sources of food supply had been laid. And their roots could be traced to the efforts of the small family subsistence farmer with his meager hand tools who, in the words of what was probably an old Pennsylvania Dutch folksong, may have wanted to call his shack "break my back" and his cow "no milk now;" their roots could be traced also to the efforts of the gentlemen farmers and planters with their large acreage, cattle, horses, slave labor, and export crops such as maize, wheat, and tobacco.



Early garden tools from Richard Bradley's Survey of Ancient Husbandry and Gardening, *1725 (Courtesy, Rare Book Collection, National Agricultural Library).*

Food Supply and the National Movement

The historian, Bernard De Voto, in his introduction to the *Journals of Lewis and Clark* interprets the Louisiana Purchase as an extremely important historical event.[20] Jefferson had been concerned about the future status of New Orleans as an outlet for agricultural production from the interior; the acquisition of this territory not only doub-

led the size of the United States but also provided rich land for the development of a more abundant food supply inclusive of the growing of wheat, corn, sugar, and the raising of cattle, sheep, and swine. The movement of population across the Alleghenies was, for many farmers, an effort to create a new source of food by developing new land that was economically cheap to acquire and potentially productive.[21]

By wagon, horse, and on foot, travel westward was plagued by physical dangers and discomforts. During the first year of settlement, land was usually partially cleared and corn was planted among the stumps. Self-sufficiency was the primary characteristic of early pioneer settlements west of the Alleghenies. It was in those regions that the small propertied farmer, although poor, showed both a willingness to work hard and a desire to improve his holdings. The success of these early pioneer farmers provided incentives for later settlers including those possessing substantial capital for investment in land and agricultural development on a larger scale. The pressures of an expanding market system characterized by the spread of country stores, credit, and wandering peddlers stimulated many frontier farmers to become more involved in commercial production.[22]

In the trans-Allegheny West, villages and towns were a vital part of the frontier settlement. After 1820, urban development in Ohio began to exceed rural expansion. Early river cities such as Cincinnati, St. Louis, and New Orleans were important centers of exchange for the early farmers west of the Alleghenies. For example, Cincinnati served as a market for the crops of farmers in the area as well as for the household wares often so difficult to obtain. New Orleans, on the other hand, served as the clearing house for large quantities of flour, pork, beef, livestock, and venison ultimately destined for the South and/or foreign markets.[23]

Improvements in turnpikes as well as in water travel encouraged farmers to produce some specialized surplus for an expanding and more accessible market economy. The advent of the steamboat on the rivers in the West after the War of 1812 reduced shipping costs both up- and downstream. The farmer not only obtained a greater margin of profit on what he sold but also paid less for the goods that he purchased. The economic benefits realized from the expansion of markets was not only a major force behind the shift from subsistence to commercial agriculture but also a stimulus to more efficient marketing techniques.[24]

With the opening of the Erie Canal in 1825, farmers in the Ohio Valley found it economically advantageous to ship large quantities of grain and provisions to eastern markets. Improved transportation and the development of substantial grist mill operations within large urban centers in the West expedited the development of large-scale markets for grains and ground products. Cities like Chicago, Detroit, Toledo, Milwaukee, and Cleveland began to export wheat in greater quantities. Clearly the productive qualities of the soil, the expanding population, and the improvement of transportation in the West made it difficult for the Western farmer to resist the opportunity to engage in specialized production for market. By 1840, a steady flow of Western agricultural products inclusive of beef, pork, wool, and cheese was finding its way into the urban centers in the Northeast and other Eastern markets.[25]

The Mormons and The Creation of a Food Supply in the Desert

Meanwhile, other pioneer farmers were on their way to the arid and forbidding land of the Far West where they would tame the desert to yield a wide variety of crops. Forced from their beautiful New England style city of Nauvoo in Illinois, with its garden plots and productive farming areas, the Mormons made their dramatic trek westward across the Great Plains--a harrowing experience documented not only in literature on the West (and in such museum artifacts as the hand cart) but also captured in part in such songs as "Come, Come Ye Saints." Few migrations west began as well prepared in the art of travel as did the Mormon expedition. Vital to their success was their sense of community, discipline, and organization. Throughout the various waves of Mormon migration, a series of shelters were set up, some more elaborate than others. Crops were usually planted as a potential food supply for later arrivals. In choosing the Salt Lake Valley as their destination and place of final settlement, the Mormon leader, Brigham Young, desired an isolated spot beyond the frontier. In July of 1847, the first group of Mormons traveling with 90 oxen, 41 cows, three bulls, and seven calves reached the Salt Lake Valley; they were soon followed by a second group with 887 cows.[26]

At first the land seemed barren--the soil was dry, hard, and alkaline in places and thought to be beyond redemption. Had Jim Bridger, the mountain man, been correct when he reportedly offered Brigham Young "one thousand dollars for a bushel of corn raised in the Basin?"[27] Furthermore, this land, apparently unfit for agricultural settlement was already inhabited in a primitive fashion by about 35,000 Indians including the Shoshone and Ute to the north and east, the Navajo and Paiute to the south, and the Gosiute or Digger Indians to the west. With an annual rainfall of eight to 16 inches per year, no navigable rivers, very little wild game, and poor grazing, the future did not look at all promising to the first Mormons in the Salt Lake Valley.[28]

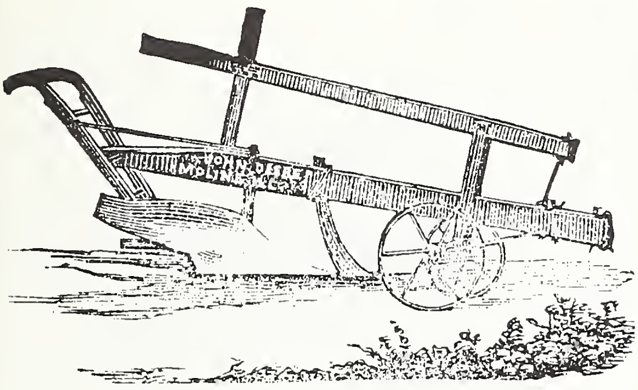
Under the inspirational leadership of Brigham Young, however, the first irrigation by English speaking people in America was begun by constructing a diversion dam across City Creek near the site of present-day Salt Lake City. Utilizing a ". . . pattern of central planning and collective labor," one segment of the advance group into the Valley cultivated and irrigated 35 acres of land and planted them in potatoes, corn, oats, buckwheat, beans, turnips, and garden seeds. Given the arid climate, the sparsity of water, and the necessity of cooperation in developing a water distribution plan, their adoption of the farm village as a method for agricultural settlement of the Great Basin area was most appropriate. In the year 1849, about 130,000 bushels of grain were raised on 17,000 acres; 16 years later, 277 canals had been built which irrigated about 153,943 acres of land.[29] Each spring, Mormon entrepreneurs would sell a portion of their vegetables, butter, milk, eggs, and chickens to overland travelers in need of reprovisioning.[30]

The Desert Agricultural and Manufacturing Society, first organized by the Mormons in 1856, promoted efforts useful to the development of an agricultural food supply including experimentation with new varieties of field crops and the distribution of seeds deemed potentially useful to farmers in the Valley. The Society became a recipient of seeds and plants distributed by the U.S. Patent Office and, later, by the U.S. Department of Agriculture. Throughout the 1860's, the Mormon agricultural program focused upon ". . . proper use of water, management of crops, and livestock enterprises, and combatting the visitations of grasshoppers, crickets and Indians."[31] Although the food supply was not always adequate and despite the havoc repeatedly inflicted by crickets, grasshoppers, droughts, floods, and blizzards, the experiment in agricultural settlement in the American desert proved a successful one. Having achieved one of the most successful colonization ventures in the westward movement, the early Mormons, in addition to developing an agricultural food supply out of unwanted desert land, left a legacy of determination, cohesiveness, and cooperation--characteristics having potential significance for the well-being of contemporary America.

Mechanical Revolution, Markets, and the Food Supply

During the first half of the nineteenth century, laborsaving farm machinery began to be invented, patented, and

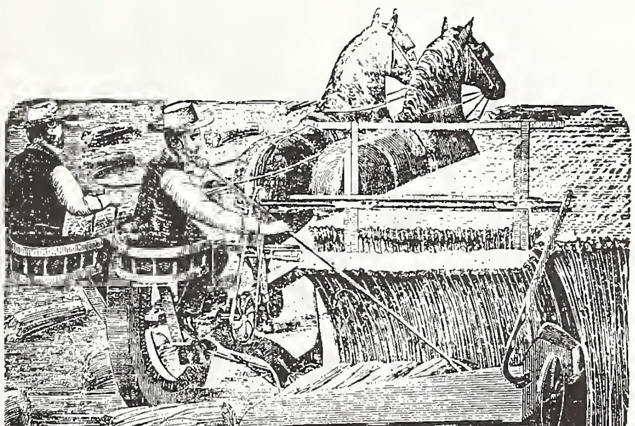
manufactured. It was a timely development for, as the pioneer settlers reached the open prairies of Indiana and Illinois, they soon realized that their conventional wooden plows were little better than useless on the tough prairie soil. Fortunately, two Illinois blacksmiths, John Lane and John Deere, invented a plow capable of turning the prairie soil which before had stuck to both wooden and iron plows. Farm technology was adapting to the "needs of



Full Rigged 24 Inch Breaker as found in Country Gentleman *10 (1857): 129 (Courtesy, National Agricultural Library)*

geography at just the right time."[32] Once the problem of tedious time-consuming labor involved in harvesting and threshing could be solved,[33] the prairies and the eastern fringe of the northern Great Plains would be rich in potential for large-scale grain production. Following the lead set by Lane and Deere, Cyrus H. McCormick of Virginia developed a labor-saving horse-drawn grain harvester in 1831. During the next 20 years, McCormick rose to the forefront in the production of mechanical reapers; he was fortunate, too, in having moved his factory to Chicago for that city soon was to become the future grain marketing center.

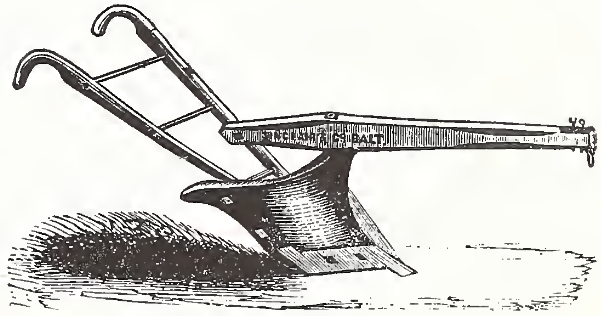
In terms of improved farm machinery, the advent of the mechanical reaper has been correctly interpreted by a leading agricultural historian as "probably the most significant invention introduced into farming between 1830 and 1860."[34] The success of the reaper stimulated the development, promotion, and adoption of other horse-powered equipment such as the widely used Pitts Grain Thresher and Separator and the Ketchum Reaper and Mower. Between 1840



Ketchum's Reaper and Mower as found in Country Gentleman *13 (1889): 301 (Courtesy, National Agricultural Library)*

and 1850, the adoption of improved farm machinery in the Midwest meant the cultivation of more land as well as increased production. As farmers turned from corn to wheat, their acreage more than doubled. In Illinois alone, wheat production increased from 3.3 to 9.4 million bushels. From 1849 to 1857, approximately one-fourth of the total number of McCormick reapers were purchased by 11 counties in Illinois. By 1860, there were approximately 80,000 reapers in service to American agriculture.[35] Then came the Civil War with its labor shortages, high prices, and increased demands for agricultural food products and feed crops. These factors further stimulated the change from manpower to horsepower--a rapid transformation interpreted by some as the first Agricultural Revolution.

The continuing advancements in agricultural technology were further stimulated by the following timely factors: the increase in foreign demand for the exportation of agricultural products from the United States resulting from the repeal of the British Corn Laws on June 26, 1846; the crop failures in Great Britain between 1860 and 1863; the general food shortages occurring in much of continental Europe during that 20 year period. After the war, the importance of machinery to agricultural production increased as further refinements and improvements continued to be made. Between 1870 and 1900, farmers found themselves producing more in order to pay for their machines. Overexpansion and recurrent surpluses kept prices low during this period. Between 1870 and 1900, agriculture lost almost 3,500,000 workers.[36]



The Patuxent Plow as found in American Farmer *(1860). This plow illustrates the many other efforts that went into developing improvements in farm machinery along the Eastern seaboard (Courtesy, National Agricultural Library)*

Continued improvements of transportation facilities in a manner economically encouraging to the flow of goods between farms and urban centers was another significant factor which influenced the specialized production of agricultural food supply for distant markets; in fact, these transportation improvements in part helped lay the foundations for an agricultural revolution.[37] Until 1845, the use of canals had been a major spearhead in promoting the development of both commercialized farming and interregional trade between the north Atlantic seaboard and the West. By the 1850's, the advantages of an expanding railroad system rose to the forefront. Settlers had entered Indiana, Illinois, Missouri, and Iowa in anticipation of the benefits to be derived from the coming of the railroad. As it so happened, the completion of railroad construction resulted in an increase in agricultural produc-

tion in these areas. By train, farmers had access to markets connected with urban centers such as Dubuque, Iowa, and St. Louis, Missouri; they could travel from Chicago to New York in less than three days rather than three weeks. In Illinois, entrepreneurs of one major railroad line recognized quickly that by providing improved transportation to the farmer, they would derive thereby both direct and indirect economic benefits.[38]

The advent of efficient railroad transportation complimented the improvement in farm machinery by promoting the development of prairie agriculture. As was once said about agricultural development in southern Iowa during this period, ". . . the machine had made commercial farming probable, but the railroad had made it possible."[39] Between 1820 and 1870, growth of markets in the increasingly food-deficient East as well as in the urban centers of the West provided the necessary economic incentives for market farming.[40] The expansion of urban centers resulted in an increase in the number of non-agricultural people dependent upon the agricultural sector for food. Farmers in different geographical regions of the country placed greater emphasis upon raising those crops and/or livestock that climate, soil, and their own capabilities allowed them to produce most profitably. For example, through experimentation, farmers migrating into Kansas from Ohio, Illinois, Indiana, Missouri, and earlier established areas of the Middle West discovered hard winter wheat to be more adaptable to the soil and climate than the wheat that they had been using. In particular, in 1874, turkey wheat was introduced successfully by Mennonites into Kansas.[41] This shift to a more regional and/or specialized approach to agriculture was reflected in the development of dairying and livestock journals such as the *Prairie Farmer*, *Iowa Homestead*, *Wallace's Farm and Dairy*, *Hoard's Dairyman*, and *Breeder's Gazette*.


HOARD'S DAIRYMAN.

Weekly Dairy Edition of the JEFFERSON COUNTY UNION, Devoted to Dairying and Dairy Stock Interests.

VOLUME XVI. FORT ATKINSON, WISCONSIN, MARCH 13, 1885. NUMBER 2


THE IOWA HOMESTEAD

DES MOINES, IOWA, FRIDAY, APRIL 2, 1883.


THE BREEDER'S GAZETTE

A WEEKLY JOURNAL FOR THE STOCK BREEDER, THE TURFMAN, THE DAIRYMAN AND THE GENERAL FARMER.

VOL. I. CHICAGO, ILL., DECEMBER 1, 1881. No. 1.

Sweepstakes Prize Winners at the Chicago Fat Stock Show.

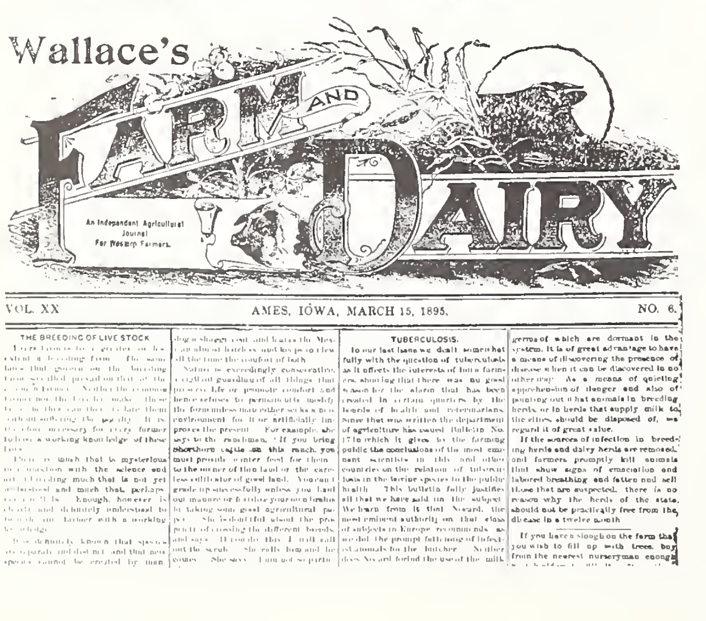
(Sketched by Dewey, and engraved expressly for THE BREEDER'S GAZETTE.)

CATTLE AT THE CHICAGO FAT STOCK SHOW OF 1881.

The cattle exhibit at this Fat Stock Show was better than that at either of the preceding exhibitions. No one animal fully equaled the grade Short-horn steer Nichols as he appeared last year, but several nearly approached him, and the average quality was decidedly in advance of the standard in previous years. The entries numbered 145 different animals; several of these were breeding animals not in competition for premiums. The various breeds were represented as follows: Short-horns, 20; grade Short-horns, 81; Herefords, 15 (of which number 10 were breeding animals); grade Herefords, 17; Devons, 8; grade Devons, 2, with one Ayrshire and one Polled Angus. Short-horns were shown by 9 exhibitors, Herefords by 4, Devons by 1. As usual, J. D. Gillett, of Elkhart, Ill., was the largest exhibitor, having 31 head of grade Short-horns, including a pen of eight white steers, which attracted much attention, although no better than his others of the same age. The fact that these were selected from 13 head, this being all the white three-year-old steers on his farm, has some bearing on the often spoken of advantage Mr. G. has in selecting from great numbers. The next largest exhibitor was J. B. Sherman, of the Union Stock Yards; the third, Morrow & Muir, of Centerville, Ky. Messrs. Miller, Culbertson and Burleigh were the exhibitors of Herefords in competition for premiums, and L. Rawson, of Oak Creek, Wis., the only exhibitor of Devons. While some of the Devons were creditable animals, the collection did not do full credit to the breed. The older animals were small for age, and were not in especially high flesh. None of them were entered in competition with other breeds. Breeders of Devons, as it seems to us, owe it to themselves and the valuable breed the reputation of which is in their hands, to see that larger and better collections are exhibited at these shows.

As in former years, there was much interest manifested in the classes in which the Herefords and Short-horns were brought into competition, and unpleasant feelings were manifested in several cases. The Board and the committees were unjustly criticised, we think, in most cases. As a whole, the judging impressed us as carefully and well done, although our personal judgment did not always coincide with that of the committees. The honors were pretty fairly divided between the two breeds; the Short-horns secured the most prizes, but the Herefords secured two of the most important ones.

The four illustrations on this page are Courtesy, National Agricultural Library


Wallace's FARM AND DAIRY

An Independent Agricultural Journal For Western Farmers.

VOL. XX AMES, IOWA, MARCH 15, 1895. NO. 6.

THE BREEDING OF LIVE STOCK

TUBERCULOSIS.

The direction taken by American agriculture was in part dramatized and influenced by the development of bonanza farms in the Red River Valley region of Minnesota and North Dakota and in the Central Valley of California. Successful farming came to mean the management of large acreage, a greater need for manpower, horsepower, and farm ma-

chinery to work the land, and the specialization of agricultural production for markets. Unfortunately, the bonanza operator soon found himself the victim of a one crop economy in which he was unable to control either his output or the prices of items bought and sold.[42] In time, however, with the assistance of agricultural scientists and extension agents, Red River farmers developed a more viable pattern of land use. Other factors contributing to the increase in agricultural output of Western farmers included plant and livestock breeding, improved methods of tillage and irrigation, increased use of fertilizers, and expanding federal policies and programs. In the long run, the achievements in improving the agricultural food supply for a growing non-agricultural population were primarily due to what has been interpreted by one scholar as "a coming together at a point in history of open lands, suitable machinery to cultivate greater acreage, and the railroad to get the expanded production to market."[43] Progress was realized despite an adverse environment seemingly at odds with the farmer; two authors, Everett Dick and O.E. Rolvaag, in their works *The Sod House Frontier* and *Giants in the Earth*, respectively, present vivid portrayals of the conflict existing between the farmer and his environment.

Structurally, the rapid development of commercial agriculture and the expanding market system for the processing and distribution of food separated the farm producer from the urban consumer.[44] In addition, it failed to bring economic stability to the farmer who was at the mercy of fluctuating prices and the continuing rise in farm operating costs. Given these unfavorable economic situations, agrarian discontent emerged, contributing to the development of the Populist and Farm Cooperative movements.

Food Supply in the Twentieth Century, 1900-1940

By 1900, the total animal power on farms--18.5 million horsepower--had tripled the estimate made in 1850 and only 38 percent of the gainfully employed were engaged in agriculture. During World War I, agricultural production increased as farmers responded to the wartime need. With government assistance, price guarantees, and other economic incentives, the rate of agricultural growth between 1913 and 1919 increased 10 percent in lands used for crops, 16 percent in feed grain production, and 26 percent in food grain production.[45] Unfortunately, however, between 1919 and 1921, a post war farm depression resulted in a net loss in total farm income of 5.7 billion dollars. With the post war decline in foreign markets, increased wheat production in the Great Plains during the 1920's seriously upset the supply and demand process thereby resulting in surpluses and low prices. The depressed wheat market adversely affected the entire Great Plain's economy. By the time of the Great Depression of the 1930's, American agriculture was a poverty stricken livelihood for many farmers. In the Great Plains, drought and dust storms added human misery to the economic distress. The states most affected by the drought conditions--North and South Dakota, Kansas, Montana, Nebraska, Utah, Oklahoma, and Texas--were also those states which received the greatest proportion of expenditures and loans. As the 1930's drew to a close, there were half a million less farm families engaged in agriculture.[46] For many, the contributing factors in this outward migration of the farm population were twofold: on the one hand, there were personal experiences with unfruitful farming or tenancy operations often accompanied by poor farming practices and eroded and/or unproductive land; on the other hand, there was the lure of apparent economic opportunity for jobs and income in one of the expanding urban centers.

The Second Agricultural Revolution

On the eve of World War II, American agriculture had accumulated, through years of research, a vast storehouse of available technical knowledge. The outbreak of World War II provided a catalyst, stimulating the availability of risk capital, providing economic incentives to accelerate the adoption of improved labor-saving technology and practices, and creating an unprecedented demand for farm commodities. An integral part of the revitalization of American agriculture was the outstanding development in marketing and transportation systems to handle the rapid post 1940 expansion in farm output. For the duration of the war, improved economic well-being was provided the farmer, thereby encouraging him to increase his adoption of and dependence upon mechanical power, machinery, fertilizer, lime, chemicals, feed, seed, and other supportive products.[47] In fact, war-related labor shortages actually stimulated the development and adoption of labor-saving machinery. Furthermore, the rapid expansion in mechanization plus the decline in farm employment had a significant influence in bringing about structural changes in agriculture. Commercial farms decreased in number yet expanded in average size.[48] In 1949, scientists with the U.S. Department of Agriculture suggested a package approach to farming--a "systems approach to the problems of increasing agricultural productivity."[49] In the West, adoption of this approach included labor-saving technological breakthroughs in the production of the tomato, sugar beet, cotton, rice, fruit, and vegetables. The commercial farmers with land and capital who effectively utilized the package idea became a part of the specialized labor force behind the Second Agricultural Revolution.

Today, cotton harvesters pick in one hour what a man could pick in 72 hours (Courtesy, The Face of Rural America: The 1976 Yearbook of Agriculture, *p. 246)*

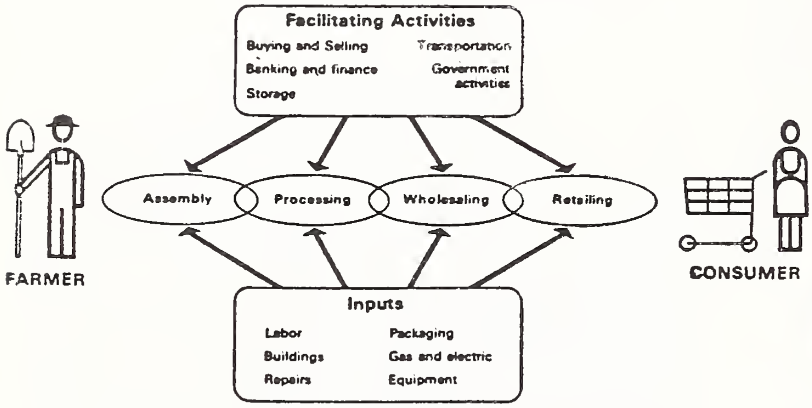
The forces of research and technology in both the public and private sectors profoundly affected improvements, changes, and breakthroughs which transformed rural America. The small farmer with an inefficient and undercapitalized operation found it increasingly difficult to survive. Unable to afford the improved products of the technological and chemical revolution and faced with a period of declining foreign markets, more frequently he chose the road to the city. The forces of research and technology also influenced the emergence in the 1950's of a broad concept called "Agribusiness"--a method for describing the extent of interdependence between the agricultural and business sectors of the economy. To be more specific, in 1956, John H. Davis, in an article appearing in the *Harvard Business Review*, coined the new word "agribusiness" and defined it as

> . . . the sum of all farming operations, plus the manufacture and distribution of all farm production supplies, plus the total of all operations performed in connection with the handling, storage, processing and distribution of farm commod-

ities. In brief agribusiness refers to the sum-total of all operations involved in the production and distribution of food and fiber.[50]

The American life style, in general, was also undergoing dramatic changes as evidenced in part by the following factors: a more mobile population; a changing value system, and changing eating habits. With improvements and increased efficiencies in food production at the farm level and expanded eating demands by a fluid population entailing the desire for more dining out, fancier and tastier foods, ready-to-cook and ready-to-eat foods, processors and retailers increased their merchandising and customer services to meet the expectations of the "new breed" of consumer. The increasing interdependence of the farmer/producer and the agriculturally related food and fiber industries became one of the most important forces influencing changes in the structure of American agriculture.[51]

MARKETING: THE LINK BETWEEN FARMERS AND CONSUMERS



Source: Post Harvest Technology Research Assessment *(Washington, D.C.: U.S. Department of Agriculture, Science and Education Administration, Agricultural Research, 1979), Figure 1, p. 146.*

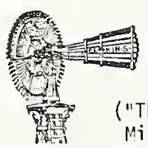
Farmer M. Heard, left, shows Obie Masingale, a work unit conservationist for the Soil Conservation Service his crop of wheat on his farm in Thomastown, Louisiana, May 2, 1963 (Courtesy, U.S. Department of Agriculture, Soil Conservation Service)

Conclusion

Today, the United States has the best food and fiber system in the world. Vital components in this success story are a more specialized, productive, and sophisticated labor force as well as continued improvements in the application of science and technology. Looking towards the future, America is entering a new era in the development of its food supply--one requiring the shared commitment from all those involved in the food and fiber system and the continued innovative support of science, technology, and the American people. Norman E. Borlaug, in his tribute lecture for the 1979 Alfred M. Landon Lectures on Public Issues held at Kansas State University, made the following comment about the future of man's food supply:

> In the next forty years, food and fiber production must be increased more than it was increased in the 12,000 year period from the discovery of agriculture up to 1975. . . . we must increase our food production from 3.3 billion metric tons to 6.6 metric tons just to maintain current (and often miserable) per capita food consumption levels.[52]

Harry Fairleigh watches wheat being harvested on his farm near Scott City, Kansas, 1962 (Courtesy, U.S. Department of Agriculture)



("The Perkins' Wind Mill" in *American Agriculturist*, August, 1880).

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(Courtesy, U.S. Department of Agriculture)

TRANSPORTATION TECHNOLOGY AND AGRICULTURE IN TWENTIETH CENTURY AMERICA

BY

DOUGLAS E. BOWERS*

Technical innovation in the twentieth century has brought substantial change to the agricultural transportation system. In 1900 farmers not situated directly on rail or water lines faced a difficult and costly task getting their products to market. By 1980 most farmers could choose between at least two different modes of transportation at costs that represented only a small portion of retail food prices. In the late 1970's there were some 2.5 million miles of surfaced rural roads, 190,000 miles of main line railroad track, and 25,000 miles of navigable inland rivers and canals.[1] Technology, however, has not solved all transportation problems and recent developments have again raised questions about the adequacy of the transportation system.

At the beginning of the twentieth century, railroads dominated the transportation scene. The canals that once carried a large share of agricultural produce had, with few exceptions, sunk into ruin and been abandoned. Country roadways were little better than they had been 50 or 100 years before--badly rutted when dry and nearly impassable when muddy. Their care was still in the hands of untrained local officials. By contrast, railroads stood near the pinnacle of their power. After several decades of extraordinary growth, the railways had developed into a nationwide system which offered the only realistic mode of transport for millions of farmers. They carried grain in box and hopper cars, livestock in ventilated livestock cars, and fruits and vegetables in cars refrigerated by blocks of ice. Railroads were benefiting from a number of technical advances introduced in the late nineteenth century, such as air brakes, automatic couplers, larger cars, heavier locomotives, steel track, better signaling devices, and a standard gauge of 4 feet 8½ inches. Rates fell while traffic increased from 79 billion ton-miles in 1890 to 142 billion ton-miles in 1900.[2]

As important as railroads were in 1900, a new technology was developing that would soon give railroads their first real competition in nearly half a century. The science of road building made great strides between the Civil War and 1900. New equipment and materials, such as steam rollers, scrapers, and Portland cement, made it possible to build better engineered roads. The Good Roads Movement of the 1880's and 1890's succeeded in pushing through road laws in several states--the first efforts by states to build roads since the ante-bellum period. The old labor tax system by which local residents worked on nearby roads was gradually replaced by a money tax. With better funding, states and counties could afford to hire trained engineers to supervise road work. In 1893 the federal government set up the Office of Roads Inquiry to study and disseminate information about roads. After 1900 the Office began testing materials and methods itself, thus becoming a leading force in the development of road technology.[3] The importance of roads to farmers was acknowledged by the fact that the Office of Roads Inquiry was placed in the Department of Agriculture where it remained (as the Bureau of Public Roads from 1916 on) until 1939.

The Good Roads Movement at first concentrated on building better roads for wagons. When automobiles, however, began appearing with regularity on country roads after 1900, they made the old style road obsolete. Almost overnight, the stone macadam road, the high point of nineteenth century road engineering, became a problem rather than an asset. The spinning wheels of motor vehicles threw up the loosely packed stones of macadam roads, destroying their surface and leaving clouds of dust. In response, state and federal governments began testing a variety of binders. Tar, Portland cement, waterproof oil-cement mixtures, and even bricks were used in rural areas.[4] Most significant for farmers at this time, however, was a new technique for improving the common dirt roads of the countryside, the King road drag. Nothing more than two split logs set at a 45 degree angle to the road, the King drag was used after a rain to shape a road so that the middle stood higher than the side for drainage. Using the drag, farmers themselves could make a hard surfaced dirt road that lasted much longer than unimproved roads.[5]

As long as only a few scattered roads were improved, motor vehicles played a small role in agricultural transport. In 1904, for example, just 154,000 in a total of about 3 million miles of roads were classified as surfaced.[6] For over 20 years after the first good roads laws, the states and private organizations made haphazard efforts to improve roads. The Federal Aid Road Act of 1916 took an important step toward uniformity by offering substantial aid to the states on the condition that they establish highway departments and follow standardized finance and maintenance requirements.[7] Trucks first developed about 1900 as modified automobiles. For years they could only go short distances because of the absence of good highways. They were also much more expensive than railroads, costing 21 cents per ton-mile compared with .744 cents.[8] Ironically, the railroads at first supported the Good Roads Movement in the hope that better roads would allow trucks to serve as feeders to rail terminals. The experience of World War I, however, when railroads were strained beyond their capacity, showed the country how important trucks could be in their own right. Immediately after the war, the federal government stepped up its road aid and an act in 1921 set up the first numbered system of highways.

By 1920 trucks were having the same destructive effect on roads that automobiles had had a few years before. The number of trucks rose sharply from 158,500 in 1915 to 1.1 million in 1920 and nearly 3.7 million in 1930. Many were owned by farmers who used them both on the farm and to help in marketing. After experiments with electricity and other forms of energy, truck manufacturers settled on inexpensive gasoline as the standard fuel.[9] However, the new trucks inflicted a severe pounding on the relatively light pavements that had been built for automobiles. Concrete roads were literally smashed by the solid rubber tires that most trucks used. Truck engines also suffered from excessive vibrations. So bad was the damage that most major highways had to be rebuilt after World War I. Following the war, state and federal governments launched an intensive research program into all aspects of road building. Trials at the Arlington Experimental Farm in Virginia proved the value of pneumatic tires in protecting roads and engines and, during the 1920's, they replaced solid tires. Better tires, in turn, allowed better road surfaces. Subsoil studies made it possible to find the best surface for each type of soil. After 1920 emphasis on federal aid roads shifted from upgrading dirt and gravel roads to applying heavy concrete and asphalt pavements.[10] Under the 1921 law, the government concentrated more of its work on main line highways instead of on local roads, leaving individual states and counties to decide how many local roads to pave. USDA's Bureau of Public Roads administered the federal program, spending an average of over $80 million a year between 1922 and 1929.[11]

The growth of road and truck technology paid off quickly for truckers who, in effect, were getting a free subsidy from the government in much the same way that land grants had benefited railroads in the nineteenth century. More-

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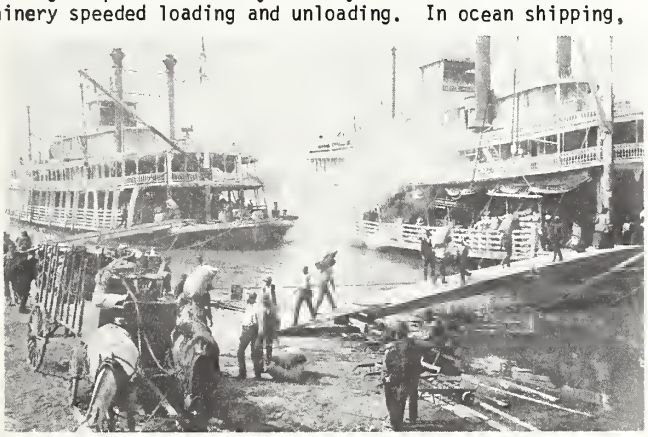
over, by the twenties, railroads were heavily regulated by the states. Trucks could not compete with railroads in cheap long distance transportation. For short hauls, however, they offered rapid door-to-door service and could reach areas not served by railroads. It is no surprise that truckers made their first inroads against railroads in carrying perishables, where speed was more important than cost. For milk, livestock, fruits, and vegetables,

In the 1920's trucks were taking an increasing share of fresh milk transportation from the railroads; Ashe County, North Carolina, 1929 (Photo, Ackerman; Courtesy, U.S. Department of Agriculture)

trucking in the 1920's took a sizeable share of business from railroads. Much of it was hauled in insulated refrigerated trucks which used ice to keep foods cool. By 1931, 75 firms built refrigerated trucks.[12] Within their range of about 50 miles, trucks altered marketing patterns, enabling wider distribution of fruits and vegetables and more centralized marketing of livestock.

Waterways also showed new signs of life in the early decades of the century for trade in semi-perishable bulk goods like grain. Between 1903 and 1918 New York spent millions of dollars rebuilding the Erie Canal to a depth of nine feet. The Erie, however, never became the great artery of trade that it had been in the previous century. Federal expenditures for harbors and channels helped greatly increase grain trade on the Great Lakes. Outlays doubled between 1900 and World War I and doubled again by 1930.[13] Deep channels permitted the use of heavy steel steamships especially made for bulk cargo. The day of the sailing ship was virtually over by 1900. New terminal machinery speeded loading and unloading. In ocean shipping,



In 1906 the loading of river boats on the Mississippi presented a scene not much different from 50 years earlier (Photo, Detroit Photo Company; Courtesy, Library of Congress)

By 1926 much progress had been made, as shown by this Florida port at St. Petersburg (Photo, Keystone View Company; Courtesy, U.S. Department of Agriculture and Library of Congress)

the American merchant marine lost out to the cheaper labor of foreign shipping companies. One technical triumph, however, stood out. In 1914 the Panama Canal opened and with a single stroke cut the distance between the east and west coasts by 7,000 miles.

Despite all the competition from other modes of transport, railroads remained supreme. Following the unhappy experience of World War I, when the railroads were operated by the government and then returned to private ownership in run-down condition, the 1920's were a period of relative prosperity. The Transportation Act of 1920, by recognizing the need of railroads for an adequate rate of return, increased railroad income to the point where they could afford to modernize. In 1923 railroad executives got together and drew up a plan for increasing efficiency throughout the industry. Between 1923 and 1930 railroads spent $6.7 billion on capital improvements, including a great many new locomotives and cars and heavier track. Electric locomotives gained favor with some companies, though they never seriously challenged steam. Automatic signaling became more common during the twenties and, along with it, the beginnings of centralized traffic control by which a single operator could oversee movement on a long stretch of main line track. This quickly reduced congestion on the most important routes. The railroads also upgraded and enlarged their yard facilities.[14]

The 1930's brought depression to the transportation industry as well as to the rest of the country. While agricultural shipments remained stable, industrial trade declined to the point where it was difficult for transportation companies to find money for improvements. Hardest hit were the railroads. New freight car deliveries plummeted 96 percent between 1929 and 1931. Burdened by an inflexible rate structure and high fixed costs, many railroads went bankrupt. By 1932 the industry as a whole was running a deficit.[15] Trouble for the railroads, however, meant opportunity for the fledgling trucking industry. Among the largest New Deal programs was one to build roads in order to put people back to work. The main intent of this aid was economic recovery but it was of immeasurable benefit to truckers as well. During the 1930's the federal government sank $3.9 billion into roads, several times the rate of expenditure in the 1920's. State and local governments added billions more. Under the national Industrial Recovery Act of 1933, the federal government once again gave serious attention to local roads as well as to major highways. This opened up more farm areas to heavy trucks. By 1940, 1.4 out of a total of 3.3 million miles of American roads had been surfaced, including nearly all the roads designated as federal highways.[16] Truck tech-

nology continued to advance during the 1930's. Most important was the development of diesel trucks. Although the diesel had been invented in Germany in the 1890's, a number of problems had to be solved before it was practical for motor vehicles. By the thirties, these problems had been worked out and the greater power and fuel economy of diesels could be used to advantage for long distance hauls. Competition from trucks now began to pose a real threat to railroads. Railroad pressure led to an act in 1935 which put trucks under the same kind of ICC jurisdiction as railroads. Inland water carriers, too, were placed under the ICC in 1940. In both cases agricultural commodities were exempted from regulation because of their seasonal nature.

World War II proved even more of a test for the transportation system than the previous war. Record amounts of cargo had to be shipped. Railroad capacity had dropped substantially during the Depression. The situation was made even worse by restrictions on the production of trucks and the rationing of gasoline and tires, all of which funneled more traffic to the railroads. The technical improvements made by the rails since World War I and their greater willingness to cooperate with each other, however, enabled railroad companies to handle the extra volume with a minimum of government intervention. Centralized traffic control did much to speed movement. Mileage under this system increased from 2,136 in 1941 to 6,495 in 1945.[17] Despite the inevitable wear on equipment, the war years were prosperous ones for the railroads.

In 1945 the railroads were in a better financial condition than they had been for many years. As in the 1920's they embarked on a massive effort to upgrade their equipment, a move made especially urgent by the now serious competition they were suffering from other modes. In fact, the technical advances and other improvements in efficiency achieved in the decade or so after 1945 represented the first serious attempt by the railroads in this century to actively compete. Innovations appeared on nearly every front. The diesel engine became feasible for railroads when combined with electric generators. First tried in a switcher in 1925, the diesel-electric caught on rapidly in the 1940's as a main line engine. Easier to maintain and more fuel efficient than steam locomotives, diesels became the dominant type within a decade. As late as 1947 over 80 percent of all locomotives were steam; by 1957 less than 10 percent were.[18] Electric locomotives reached their peak in the 1940's and thereafter began a slow decline, largely thanks to the diesel. Freight cars underwent substantial change, too. The general purpose boxcar, long the staple for many different kinds of freight, lost ground to specialized cars designed for limited use. The covered hopper car began to become important in hauling dry bulk commodities, especially grain. Refrigerator cars received a boost in 1949 with the introduction of mechanical refrigeration, which allowed frozen foods to be hauled at zero degrees. It was well into the 1960's, however, before they made serious inroads on the older ice bunker cars. Truck competition had an important effect on railroad cars--both refrigerator and animal cars declined in number in the 1940's and 1950's due to the loss of livestock, fruit, and vegetable traffic. On the other hand, railroads in the mid-1950's began the first large scale use of piggyback cars--flatcars that could hold truck trailers. Though never above two percent of car loadings in the 1950's, piggybacks enabled railroads to compete directly with trucks by hauling trailers long distances at less cost than on the road.[19]

Mechanical refrigerator cars were beginning to replace the ice bunker type in the 1950's as this 50-foot example illustrates. Mechanical refrigeration insured that frozen foods could be carried safely (Courtesy, U.S. Department of Agriculture)

Progress was also apparent in rail yards where automation was the watchword during the fifties. Using radar controlled automatic braking systems and electronic devices to identify cars, the new yards of the 1950's allowed trains to be made up by a single man in a tower throwing switches by remote control. Radar controlled brakes appeared in 1952 and the first "push button" yard in 1955. By 1957 there were some 30 automated yards in operation.[20] Similar advances were being made in communications. Radio transmitters became widespread in locomotives and cabooses. Centralized traffic control expanded rapidly in the 1950's. Computers began to be used for railroad bookkeeping--indeed, railroads were among the first industries to use computers. Many of these new operating techniques were developed by the Association of American Railroads (AAR) which sponsored an extensive research program. Railroads, however, were hampered by opposition from labor unions since most of the new technologies meant a savings in labor. The number of railroad employees fell steadily from 1.3 million in 1947 to 665,000 in 1964.[21]

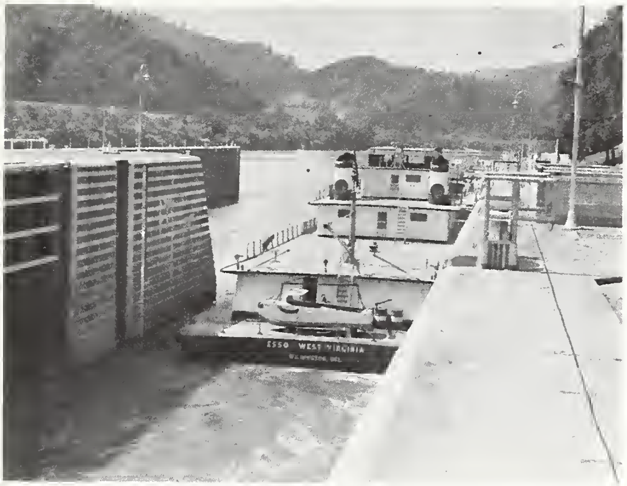
While railroads were modernizing in the post war period, they also were steadily increasing their rates for the first time since 1920. This made rails more vulnerable to competition and prevented them from reversing the flow of traffic elsewhere. Truck registrations rose from 5 million in 1945 to nearly 12 million in 1960. About one-fourth of all trucks were owned by farmers. By 1964 trucks carried 95 percent of the cattle, 82 percent of the sheep and lambs, and nearly all of the hogs to most important markets.[22] Fruit and vegetable transport by truck also made impressive gains. Trucks continued to benefit

By the 1950's open topped hopper trucks were loading grapefruit and other produce directly in the fields (Photo, John McKinney; Courtesy, U.S. Department of Agriculture)

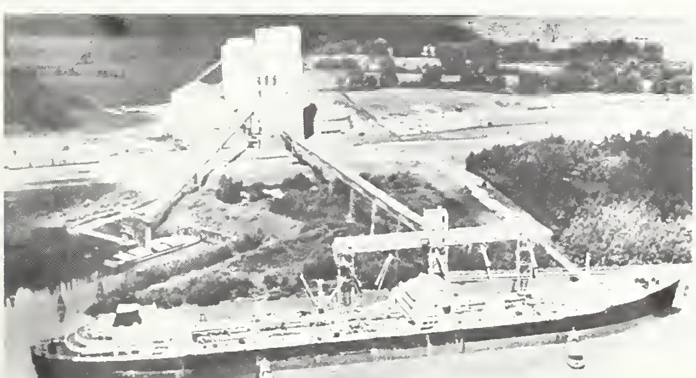
from federal highway subsidies. In 1944 the government set up a system of interstate highways comprising some 37,000 miles. Under a 1956 act, those highways received a large infusion of federal aid. By 1960 nearly 70 percent of rural roads for both long and short hauls and the unregulated agricultural truckers moved in aggressively. Even grain became the object of competition, although railroads retained their advantage for long hauls. Truckers were aided by improvements in equipment. Thirty-foot trailers grew to 40-foot trailers in the 1950's. Power steering and power brakes made truck driving easier; the use of lighter materials such as aluminum and fiberglass

made it more economical. Diesels became the principal engine for large trucks though many smaller trucks still used gasoline. As with railroad cars, specialized units entered the market, including closed hopper trailers for grain and improved livestock carriers. Similarly, mechanical and dry ice refrigeration was replacing the older water ice type. The new refrigerated trucks were larger and had better insulation. So important had the transport of perishables become that between 1954 and 1963, 9 percent of total trailer production could be used for refrigerated shipping.[24]

Waterways also gained traffic at the expense of railroads. Aided by government improvements of locks, dams, and channels, barges were becoming even more efficient at hauling long distance bulk commodities like grain. Aluminum and welded steel supplanted heavier construction. Barges capable of carrying 1,500 tons of grain (the equal of 25 rail cars) became commonplace. So did powerful diesel towboats. For ocean transport, bulk carriers overtook freighters in size. Large bulk carriers and tankers lowered the cost of shipping grain. Finally, a new form of transportation, air freight, appeared on the periphery of agricultural trade. For certain very specialized markets where speed was all important, like fresh strawberries and cut flowers, air freight made inroads. Its expense, however, put a limit on expansion. In 1960 air shipments comprised a mere .1 percent of total freight.[25] The relative position of carriers in 1960 reveals much about what happened in the transportation industry after World War II. In 1945 railroads still hauled 68.6 percent of intercity ton-miles; by 1960 this had dropped to 44.7 percent. Motor vehicles, on the other hand, increased their share from 6.2 to 21.5 percent and inland waterways from 13.3 to 16.6 percent.[26] The era of railroad dominance was over.



One of the new high horsepower towboats that appeared on inland waters in the 1960's. Such towboats permitted the use of larger barges and longer tows (Courtesy, U.S. Department of Agriculture, Soil Conservation Service)



A new supertanker, the United States' the Manhattan, *loads up with wheat for India at New Orleans, Louisiana, 1966 (Courtesy, U.S. Department of Agriculture)*

During the 1960's most technical innovation continued to come from the railroads but they were unable to prevent further loss of traffic. By using very large covered hopper cars of 100 tons or more, such as the so-called "Big John" car, railroads achieved economies of scale that enabled them to lower rates on large shipments of grain. Even greater savings occurred when a number of hopper cars were linked together to form a unit train which carried nothing but grain. To pull these heavy loads, railroads bought new high horsepower locomotives. In 1970 the AAR launched a computerized information system called TRAIN to locate freight cars as they passed from one railroad system to another. Improvements in track, such as continuously welded rail, reduced wear and maintenance.[27] Railroads also supported an effort to make intermodal transportation easier. They bought larger piggyback cars capable of holding two trailers. Piggyback loadings tripled

Carrying grain in covered hopper cars was the most efficient form of agricultural transportation by rail. Here, a hopper is being rapidly filled in Illinois, 1973 (Photo, David F. Warren; Courtesy, U.S. Department of Agriculture)

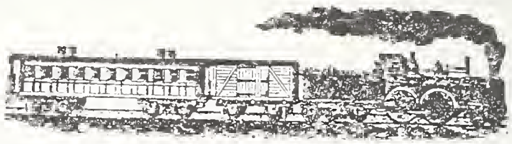
A grain-laden truck enters a railroad terminal in Illinois where the grain will be transferred to covered hopper cars (Photo, David Warren; Courtesy, U.S. Department of Agriculture)

in the sixties. Containerization, the use of large enclosed receptacles to transport commodities from origin to final destination without the need to break down into smaller sizes, caught on as a means to reduce handling between modes. Containers were too expensive to use for grain but for perishables, such as Hawaiian pineapples, they enabled shippers to transport produce as a single unit in trucks, ships, and railroad cars.[28] These various economies, however, were not enough to reverse the deteriorating position of railroads and, by 1970, their share of traffic had slipped to 39.8 percent. Profits went down, too. By the late sixties the rate of return for the industry as a whole had dropped to under 3 percent.[29] Attempts to consolidate rail lines in order to eliminate excess service had only indifferent success. The spectacular bankruptcy in 1970 of the Penn Central, the nation's largest railroad, dramatically illustrated how bad railroad financial problems had become. Low profits, of course, left less money to be invested in technology. Maintenance fell and improvements were postponed.

In the 1970's transportation problems reached crisis proportions for railroads and spilled over into other segments of the industry as well. The great expansion of exports in the seventies along with the government's full production policies put a strain on transportation capacity unprecedented in peacetime. Grain and soybeans experienced the worst problems. Huge Soviet grain sales in 1972-74 caught the railroads by surprise and it was only with the greatest difficulty that the grain could be moved. Much railroad traffic had to be diverted to trucks because of a car shortage. The major ports choked with congestion. Other big tie-ups occurred during peak demand seasons throughout the later 1970's. In a sense, railroads were tied down to their own technology. The specialized cars that were replacing general purpose boxcars, for example, made it harder for railroads to meet sudden surges in demand by shifting boxcars to agricultural transportation. Car capacity climbed in the 1970's but flexibility decreased. Between 1960 and 1973 the supply of general boxcars declined by nearly half.[30] Even worse was the energy crisis following the rapid increase of oil prices after 1973. The spread of trucking had been made possible by cheap energy. When fuel prices rose, trucking stood out as the least energy efficient mode of transportation. In 1978 trucks consumed 1.8 percent of total U.S. energy, compared with only .7 percent for railroads which carried nearly 50 percent more freight.[31] The more efficient railroads, however, were in no position to recapture their former supremacy. Indeed, at a time when the energy advantages of railroads were becoming more obvious, railroads were abandoning large segments of track in order to cut expenses. Thousands of miles of other branch lines were in such poor condition that the largest most modern cars could not use them. From the mid-sixties to the late seventies, the railroads dropped fully 10 percent of their total mileage. Critical grain carriers like the Rock Island and Milwaukee lines went bankrupt, ending rail service to large parts of the North Central region. Because of rail cutbacks, many farm communities were forced to switch to trucks. Not only did this raise transportation bills for farmers, it also compelled heavy trucks to travel on roads and bridges not prepared to handle them. In 1970 it was estimated that about half of rural road mileage was unsuited for large trucks.[32] The drawbacks of barge transportation were also apparent. While cheaper than any other mode and as fuel efficient as railroads, barges could not be operated nationwide in the winter and the small size of the Locks and Dam 26 on the Mississippi River at Alton, Illinois, limited the growth of river grain trade. Barges were also by far the slowest form of agricultural transportation.[33]

Despite problems in the transportation industry, technology continued to move forward in the 1970's. The government stepped in to help the ailing railroads. Under acts in 1973 and in 1976, Congress not only bailed out several bankrupt northeastern lines with a quasi-public corporation, Conrail, but it also for the first time appropriated billions to rehabilitate track and equipment. States were encouraged to save branch lines threatened with abandonment. Railroads also made improvements on their own. They increased average car size and average miles traveled per day. For a time, automatic car identification systems were popular but operational problems brought an end to the industry's mandatory program in 1977. Railroads did, however, make progress in updating their computers. A more sophisticated TRAIN 2 system began operation in 1975 and some railroads began using computers to dispatch cars. In response to the energy crisis, railroads made adjustments to save fuel and succeeded in raising the gross ton-miles per gallon from 493 in 1971 to 536 in 1979.[34] Truck builders also made refinements that increased fuel economy. They streamlined vehicles to reduce drag and used more lightweight materials like aluminum in construction. Beginning with a voluntary fuel reduction program in 1975, manufacturers offered a number of options that together had the potential of saving 15-25 percent in fuel. They also took steps to control exhaust emissions and reduce noise. The interstate highway system was nearly complete by 1980.[35] Barge operators likewise made improvements. Dry cargo capacity jumped 88 percent between 1963 and 1975. Large towboats with 5,000-6,000 horsepower replaced smaller ones. A 35 barge tow could carry as much grain as three 100 car unit trains or 1,440 semi-tractor trailers. In the late 1970's the government finally moved to replace Locks and Dam 26. Containerization also made some progress though less for agriculture than for other areas. In a few cases ships capable of loading entire barges (fishybacks) were used for agricultural shipments.[36] All these innovations increased the efficiency of the transportation system. Major breakthroughs, however, that might significantly alter transportation or solve the energy problem--such as high speed railroads or alternative fuels and engines--seemed a long way off as the 1980's began.

The transportation system today is adequate to meet most of the demands placed on it but the outlook for the future is cloudy. If agricultural exports keep growing at the same time that energy costs are rising and railroads are abandoning service, transportation may become more expensive and more uncertain for farmers. To insure that transportation remains efficient and reliable will require a large investment on the part of both government agencies and private investors.



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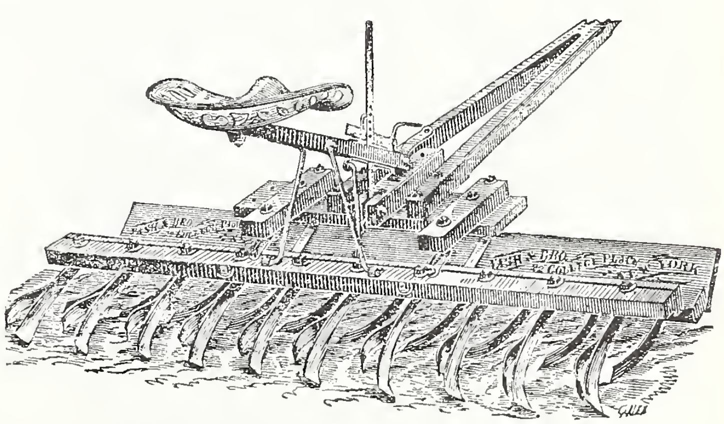

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FOOD TECHNOLOGY IN THE 20TH CENTURY

BY

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Food is energy. It gives people the power to think and act and so conditions other aims and achievements. In the twentieth century, the United States has fought two world wars and two smaller ones, experienced a great depression and a great inflation, witnessed an unprecedented civil rights movement and the beginning of space exploration, gone through a demographic transition from a predominantly rural to a predominantly urban population, defeated a host of diseases, entered a fuel crisis, and there are still two decades yet to come. In part, all these events weighed upon the food supply. Brillat-Savarin probably exaggerated in writing that "the destiny of nations depends upon the manner in which they nourish themselves." But, he had a point.

Since 1900 there have been at least a half dozen propelling forces on both the demand and supply sides of the food industry. Foremost, population growth nearly tripled the number of mouths to feed. The population grew faster in the nineteenth century, but the numbers were smaller then. Less than 76 million people lived in the United States at the beginning of the twentieth century; in 1980, almost 223 million. Parson Malthus might have guessed such enormous numbers, but he could have hardly imagined that so many would have so much to eat.

The population not only increased, it also concentrated in cities. The 1920 Census reported the demographic shift from rural to urban. City people have always exerted the lion's share of economic control over the food industry, only more so in the twentieth century. Large volume brewing, meat packing, grain milling, baking, and canning already existed to serve the urban population before 1900, but the growth of cities afterwards encouraged smaller industries (e.g. dairying, soft drinks, candy, and breakfast cereals) into larger scale operations. City people demanded food in a certain quantity, of a certain quality, and in an appropriate mix and used their political, economic, and social influence to get what they wanted.

Urban development also spread out the geography of demand, particularly in the region that came to be known as "the sun belt." Between 1920 and 1970, Albuquerque's population grew from 15,157 to 243,751; Corpus Christie, from 10,522 to 204,525; Tucson, from 20,292 to 262,933. Suburban towns--the bedroom communities of the northern industrial centers--also became cities in their own right. Skokie, Illinois had only 763 people in 1920 and 68,627 in 1970. Dearborn, Michigan grew from 2,470 to 104,199 at the same time. Evansville, Tampa, Honolulu, Long Beach, Omaha, El Paso, and Jacksonville all ranked in the top 100 urban centers with populations above 100,000 by the 1970 Census. Somewhat like the westward movement in the nineteenth century, the growth of dispersed urban centers since 1900 required a technology that made food "moveable" over space and time to a greater extent than ever before.[1]

Twentieth century Americans enjoyed a generally rising standard of living, affecting their demand for food. While labor organizations pushed wages up, technology worked to reduce production costs. Until recently, relatively low interest rates and wage inflation benefited lower income workers. Though people spent more for food, the expenditure represented a decreasing share of their disposable income. The percent of income an average family budgets today for food is about half of what it was in 1930. Since World War II, the food price index has rarely risen above the overall consumer price index. As the standard of living rose, dietary differences tended to diminish between income and regional groups. Few people now consider artichokes, asparagus, and almonds as true delicacies. Mark Twain thought cauliflower was "nothing but cabbage with a college education," but its status has fallen since his time. At their dinner tables, most Americans ate similar proportions of meat and vegetables, cereals, and dairy products as the century progressed.[2]

Social attitudes have sometimes affected the demand for certain foods. Ice cream and soft drink consumption, for example, dramatically increased during the Prohibition years. But, more often, social attitudes influence the form of food consumption. Concern over obesity and serum cholesterol partly explain the shift from butter to margarine and skim milk in the national diet. Ownership and use of automobiles did not create the "fast foods" craze, but the "drive-in" restaurant did make the "burger, fries and shake" menu a distinctive form of "gobble, gulp and go" at practically every road intersection in the country. And, the relationship between the increasing numbers of women in the wage-labor force and the rise of the "TV-dinner" probably involves more than a simple coincidence. With all their attending virtues and faults, "convenience" foods have reflected a society moving faster and farther than before, in many directions.

Wars have always put special demands on the food supply. Soldiering, simply, requires more calories than most other kinds of work. A combat loaded Marine in World War II typically carried about one hundred pounds of gear. The prospects of battle and other environmental stresses affected soldiers' metabolic rate, making the utilization of most nutrients relatively inefficient. Also, armies needed more food than comparable civilian groups because the amount of food wasted in warfare was usually enormous. For American forces alone in World War I, the canned food ration for one day amounted to 275,000 cans of evaporated milk, 130,000 cans of tomatoes, 36,000 cans of corn, 24,000 cans of peas, and so on for green beans, cabbage, peaches, pineapples, apricots, and pumpkins. The number of men and women serving in World War I was 4.7 million; World War II, 16.4 million; Korea, 5.8 million, and Vietnam, 8.7 million. Both World Wars required food rationing in the United States and food relief programs for Europe after peace. Supposedly, a German general in 1945 hoped that in the next war he would have British uniforms, Russian tanks, and American food.[3]

The demand side of the food industry involves many more factors than these. Why some people esteem oysters, while others will eat no pie other than rhubarb are not as simple questions as they seem. In 1850, a German traveler wrote:

> It could be assumed that in the United States, where wheat is cultivated in such large quantities and such excellent flour is made, that one will find tasty bread; however, one generally finds even in the large cities, where bread is baked by bakers, a light, spongy product that cannot compare with the pithy, tasty German bread. This is not due to lack of skill of the bakers but to the predominant taste; the Americans like light, spongy, white bread, and they prefer freshly baked and even hot bread to any other.[4]

The success of "Wonder Bread" may be more complicated than the clever promotion of "One squeeze tells you we're THE FRESH ONES." Food habits in themselves give the demand side an almost limitless expanse. The supply side, ultimately, is less complicated.

Many of the technological and economic forces presently at work in the food supply existed a century or two ago. The

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automated processing going on in a modern canning factory had precedent in the mechanized flour mill Oliver Evans designed in 1783, and the factory manufacture of butter, cheese, ice cream, condensed milk, pasta, crackers, canned peaches, and beer all began before the Civil War. Such companies as H.J. Heinz, Washburn-Crosby (later General Mills), Pillsbury, Campbell Soup, American Sugar Refining, and William Wrigley started in the nineteenth century.

Inspection of bread and crackerbaking; note cracker machine, 1920's (Food and Drug Administration; Courtesy, National Archives)

But, sometime after 1900, especially after 1945, the degrees of technological specialization and economic organization passed an irreversible "critical point" that changed the food industry from its earlier resemblance. Changes were apparent all along the food lifeline between farmers and consumers.

In the 1870's railroads transformed eating in the United States by bringing Maine lobsters to Chicago, Georgia peaches to New York, and Texas beef to Boston. Freight rates favored high volume long hauls, and terminal complexes developed with grain elevators, stockyards, warehouses, and ice dealers around the rail head. The number of freight cars in service increased to a peak 2,414,083 in 1925, then gradually fell off to 66,185 in 1970. For short hauls, horse wagons served the transportation needs of food distributors before World War I. Great teams pulled wagon loads of beer and flour, while many bakeries, dairies, and fresh produce dealers had one-horse carts for home deliveries. Road conditions limited long distance wagon transportation. In 1904, at the beginning of the automotive age, surfaced road mileage in the United States was 154,000 miles, compared to 297,073 miles of railroad track. The Federal Highway Act of 1921, however, started a major construction program. By 1930, when railroad track mileage reached its peak at 429,883 miles, surfaced roads in service already spanned 694,000 miles. In 1970, there were 2,946,000 miles of surfaced raods in the United States.[5]

Motor truck registrations rose almost exponentially with road building. The 700 trucks registered in 1904 increased to 18.7 million in 1970. The obvious advantage over horse wagons was that trucks could haul heavier loads for greater distances in shorter periods of time. The introduction of pneumatic tires, enclosed insulated bodies, and mechanical or dry ice refrigeration, in the 1920's, made trucks suitable for hauling practically everything from ice cream to eggs in inter-city traffic. During the Great Depression, when railroads enlarged the size of freight cars to offer more competitive shipping rates, trucks continued to make gains in transporting food because both wholesalers and retail grocers needed to keep their inventories low. Trucks provided smaller volume shipments and door-to-door services, while their economic range lengthened with better engines, transmissions, mechanical lifts, and container design. Transportation improvements created a new system for food distribution in the twentieth century.[6]

Electrification in the food industry, as in most manufacturing, freed production from the limitations of waterwheels and steam engines. Individual power stations supplied electricity to some processing plants well before 1900. The first all-electric flour mill, for example, was set up at Laramie, Wyoming in 1887. Segregated power stations were not well equipped to handle peak loads, however, until the grid system was improved after World War I. Since 1920, electrical energy production roughly doubled each decade, from 56,559 million kilowatt hours in 1920 to 1,639,771 million kilowatt hours in 1970.[7]

As more power became available, food factory operators installed small electric motors to operate machinery, resulting in several improvements. First off, electric motors were quieter than throbbing steam engines and, with motors incorporated into individual machines, it was possible to dispose of the belt drive transmissions that cluttered the factory. Second, electric drive allowed plant managers to exert closer control over the synchronization of automated steps, as in canning or bottle filling lines. With the improvements in moisture-proof switches, connections and automatic controls, milk, soup, beer, and soft drink factories shifted to electrical motors. And, third, electricity was relatively cheap, especially when the early utility companies offered favorable rates to build up their loads.[8]

By 1920, electric power supplied about half of the energy in merchant flour milling, even for the mills at the Falls of the St. Anthony in Minneapolis. In the next two decades, the ratio of electricity to steam power in milling increased four to one. Dairies and canning plants needed

Process of halving and pitting yellow Cling peaches, Libby, McNeill, and Libby, 1948 (Courtesy, National Canners Association)

steam for sterilization in their processes and so held on to their coal-fired boilers for many years but, by 1963, dairies ranked first among processors using electricity, followed by grain mills, canning and frozen food lines, beverage bottlers, fat and oil renders, bakeries, meat packers, and sugar refiners.[9]

With greater power to produce also came safer, brighter, and more dependable lighting, better sanitation equipment and, eventually, climate control air-conditioning. In flour milling and baking, electric air-conditioning worked to keep the flour and dough at the right temperature and humidity before and during processing, year round. Meat packing and milk storage benefited from cold air refrigeration, as did brewing. Electricity found its most important use in refrigeration, in the operation of automatic ice machines and freezer-compressors in the 1930's. Mechanical refrigeration freed ice cream production, for example, from the messy and expensive ice and salt system.[10]

Beginning in 1973, electrical costs began rising dramatically because of the foreign oil embargo, although price differentials existed in various parts of the country. The rate for 120,000 kilowatt-hours in Tennessee was $868 compared to $2,052 in Maine. As food processors dispersed or concentrated to take advantage of favorable transportation rates earlier in the century, the cost of electricity for the remainder of the century could promote a shift in industry location. Clearly, electric power was a revolu-

tionary force in food processing.[11]

By 1914, Americans were becoming familiar with a number of new foods their parents had not known. Ready-to-eat breakfast cereals became popular just before World War I. In 1893, Henry Perky and William Ford in Watertown, New York, figured out a way to extrude whole wheat flour in such a way that it could be woven into "shredded wheat." C.W. Post "invented" a breakfast cereal in 1904 that he called "Elijah's Manna," but because ministers complained about commercializing the Bible, he changed the name to "Post Toasties." At the St. Louis Louisiana Purchase Exposition in 1904, Alexander Anderson, a botanist from the New York Botanic Gardens, exhibited his process for steaming rice under high pressure. Quite literally, he demonstrated how "puffed rice" was shot from guns. Supposedly, the ice cream cone and hot dog originated at the St. Louis Fair. In 1911, Procter and Gamble introduced "Crisco," the first hydrogenated vegetable oil shortening, and such

Factory processing of Crisco, Procter and Gamble Company; packing line at plant in Ivorydale about 1915 (Courtesy, the author)

products as "Minute Tapioca" (1894), "Jell-O" gelatin (1897), and "Life Savers" candy (1913) were entering the grocery parade.[12]

Canning, or thermal processing, was the nineteenth century's most important contribution to food preservation technology. Forced air drying, freezing, and irradiation largely belonged to the twentieth century. The cost of shipping food to Europe during World War I stimulated interest in drying technology, although American and German processors had set up egg drying plants in China during the 1880's, and R.J. Allen invented the "Oregon tunnel" dryer in 1890. Between 1915 and 1940 engineers designed new drum dryers for potato flakes, soup mixes, and tomato powder and spray dryers for milk and egg products. But, during World War II, drying technology took its greatest step forward. In 1942, the War Production Board and the Quartermaster General set up the Joint Dehydration Committee to establish production goals for dried foods and the means to meet them. Researchers at the University of California in Davis developed the continuous-tray dryer in 1943 and, by 1944, dried food production reached astonishing levels: 160,000 tons of egg solids; 89,000 tons of whole milk; 291,000 tons of nonfat milk; 66,000 tons of potato flakes; 38,000 tons of other vegetables, and 582,000 tons of dried fruits. The Quartermaster Corps orders for 25 million pounds of instant coffee during the war initiated experiments with freeze-drying and the decaffeination process. Soldiers apparently had little passion for dried eggs and production fell off immediately after 1945; however, instant coffee and nonfat dried milk were successes in the war and afterwards. General Foods began marketing "Instant Sanka" (i.e. "sans caffeine") in 1946 and instant "Maxwell House" in 1950. By 1960, nonfat dried milk had increased to 909,000 tons, by far the largest dehydrated food product.[13]

Traditionally, Clarence Birdseye (1886-1956) is credited as "the father of frozen foods" but, in fact, Enoch Piper of Camden, Maine received a patent for freezing fish (U.S. #31,736) in 1861 and the commercial freezing of fish and poultry began during the Civil War. Frozen shellfish, shell-less eggs, meats, and berries were available at groceries in the major cities by 1910. But slow freezing, using pans emersed in ice or brine, allowed enzymes to act on the foods' texture and flavor. Musty fish and mushy strawberries attracted few buyers. Birdseye's success was in developing a quick freezing method. His "Double Belt Froster" was a machine in which two refrigerated stainless steel belts simultaneously froze packages of food on both sides as they moved down a conveyor line; "Quick-frozen," a term Birdseye coined, prevented the loss of flavor, color, and nutritive value and actually improved the color of many green vegetables. Even before he received patents on the process in 1930 (U.S. #1,773,079; #1,773,080; #1,773,081), the Postum Company (later General Foods) bought the rights to manufacture and distribute "Birdseye Frosted Foods."[14]

Clarence Birdseye (1886-1956) was a pioneer in the development of frozen foods and was founder of Birds Eye Products (Courtesy, General Foods Corporation)

Because canned and dried foods were being diverted for the military during World War II, frozen foods gained quick popularity in the domestic market. After the war, frozen foods rose from $257 million in 1945 to $1,700 million in 1955 to $6,245 million in 1965. The glamor product of the frozen food trade was orange juice concentrate, introduced in 1946, with a production then of 559,000 gallons. In just twenty years, frozen orange juice increased by 2,500% to 127,610,559 gallons. Until 1940, Florida and California each accounted for about half of the oranges raised in the United States but, with the construction of frozen concentrate factories in Florida after World War II and convenient refrigerated railroad transportation to the eastern cities, Florida produced 90% of the orange crop by 1959. There is perhaps no better example of the application of energy to food preservation than orange juice that is processed and frozen in Florida, shipped frozen in refrigerated railroad cars and trucks, kept frozen in supermarket cabinets and home freezers, and consumed for about a half dollar per quart (April 1, 1980).[15]

The irradiation of food to prevent spoilage was a spinoff of the nuclear technology in World War II. By 1953, scientists at the Massachusetts Institute of Technology had published reports on cathode ray irradiation eliminating Salmonella and the comparative bacterial effects of various types of high energy radiations on a variety of foods. The United States Atomic Energy Commission and the Army Quartermaster Food and Container Institute carried out further studies on sterilization and pasteurization during the 1950's and the Army installed a 24 Merv linear accelerator and a megacurie cobalt-60 source at its Ionizing Radiation Center at Natick, Massachusetts in 1967. Consumption tests with volunteer soldiers revealed no

harmful effects. Pork loin, irradiated to inactivate its enzymes, was stored for a year at room temperature and judged equally acceptable as fresh pork. Scientists were able to point to several advantages of irradiation by 1970. First, it made refrigeration for some foods (dairy, in particular) unnecessary in transportation, storage, marketing, and in homes. Second, it prolonged the "shelf-life" of fresh meats and vegetables. Third, irradiation killed insects and bacteria at all their life cycle stages without harmful nutritional side effects. Fourth, it inhibited sprouting in potatoes and onions. And, fifth, irradiation favorably affected meat tenderness, aging in wine, and the flavor potential of roasted coffee. While the Army built up evidence in support of irradiated stabilized or treated foods, however, the Food and Drug Administration disapproved the sale of such products in the civilian market until the safety of the process was assured for each food category. Obviously, the concern over irradiation technology in the food supply was part of the general uncertainty about the peaceful uses of nuclear power. Quite likely, food irradiation will remain in a technological reserve until such time as its use is critically necessary.[16]

Since 1940, the per capita consumption of processed foods has changed considerably. Margarine consumption doubled from 6.1 pounds to 12 pounds in 1978. Frozen vegetables, fruits, and juices all increased. Other items fell. Canned fruit declined slightly from 21.6 pounds to 19 pounds between 1940 and 1978; canned milk fell from 19.3 pounds to 3.1 pounds. Fresh milk dropped from 331 pounds to 285.9 pounds, but fresh eggs went from 319 to 35.2. These figures, however, did not include the ingredients that went into "Bisquick," "Cool-Whip," and "Egg Beaters."[17]

Of all the twentieth century's technological achievements in food processing none has had a more controversial impact than chemical additives. The label on a package of instant soup or hamburger extender reveals a technological tour de force. Now added to food are enzymes to assist in curing flavor or texture, vitamins and amino acids for nutrition, antimicrobial substances (e.g. sorbic acids to control yeast and mold growth), nitrates to kill botulism and other bacteria, acidulants to modify flavor, nonnutritive sweeteners, artificial flavors and colors, chemical leavening agents, and so on. The purposeful addition of chemicals to food has, of course, accompanied human history. Likewise, the concern over the safety of food additives has a lengthy history. Two authors illustrate the spectrum of thought about alimentary chemicals. T.D. Luckey, in his introduction to *The Handbook of Food Additives*, observed that "food additives include the most useful, most well tested, most justified, best controlled, most discussed, most legalized and least maligned of the materials that man adds to his environment in Quixotic maneuvers to keep nutritional supplies ahead of the population explosion." In contrast, Colman McCarthy, writing in *The New Republic*, described a new snack food in this way:

> The glop oozed in the cooking pan in a lava-spread of fakery. Mingled with the sauce, like rocks in creek-bottom muck, were artificial meatballs, a concoction of imitation beef with textured vegetable protein, all of it flavored by a mystery chemical called D515.

Opinions about taste, like beauty, differ in the judgments of beholders but scares, such as those over monosodium glutamate and cyclamates in the 1960's, raised more critical concerns over the safety of food additives.[18]

Of course, not all the controversy over chemical additives has been about their safety or taste. Simple nutrition and the economics of additives raised other questions, particularly over the vitamin fortification of foods. In 1912, Casimir Funk coined the word "vitamine" to describe a group of chemical substances scientists had investigated for three quarters of a century. Then, in 1913, Elmer V. McCollum isolated vitamin A and discussed its role in human growth, reproduction, night vision, and the prevention of blindness. The discovery of vitamins shifted the study of nutritional deficiency diseases from the sole concern with bacteria to the investigation of chemicals that existed in foods in quantities too small to be measured. Work with vitamins led to understanding of how trace elements-- iodine, copper, fluorine, and cobalt-- affected diet and health. In 1922, McCollum also discovered that vitamin D prevented rickets and, in 1925, Alfred Hess and Harry Steenbock, at the University of Wisconsin, developed the ultra-violet light method of fortifying milk with vitamin D. The Borden Company first marketed irradiated vitamin D milk in Detroit in 1932. Vitamin pill consumption increased astonishingly after World War II, from 2,516,000 pounds in 1945 to 12,324,000 pounds in 1968.[19]

The discoverers of vitamins, however, did not necessarily support the drive to fortify all foods or the notion that people ought to take vitamin supplements to insure proper nutrition. McCollum, for example, argued against the enrichment of bread flour, insisting that adding vitamins did not entirely replace the nutrients lost in highly refined flour. The idea that even "balanced diets" did not provide adequate nutrition was and remains a hoax in commercial advertising.[20]

As for the economic questions about vitamin fortification, investigators at the Center for Science in the Public Interest showed that the nutritional difference between "Wheaties" and "Total," both General Mills breakfast cereals, was one-third of a cent worth of vitamins added to enrich "Total." The grocery store difference in price was, however, twenty-six cents. Of course, one only has to shop in a "health-food" store to discover that the absence of artificial colors and flavors and synthetic vitamins and chemical preservatives does not necessarily make food less expensive.[21]

Congress recognized both the risks and benefits of food additives in the Pure Food Act of 1906, the Food, Drug, and Cosmetic Act of 1938 and subsequent amendments to those laws. While the definition of "safety" for chemicals remained unclear, the search for means of judging food safety, particularly regarding additives, carried science into the food system during the twentieth century as never before.

Packaging was always an integral part of the food supply. "Canning," of course, took its name from the package rather than the process. Changes in packaging necessarily accompanied other changes in food manufacture, transportation, and marketing that were already taking place before the twentieth century began. William Painter's design of the crown seal in 1892 came with "Coca-Cola's" and "Brad's Drinks" (later Pepsi Cola) beginnings. Robert Gair patented the automatic cutter-creaser for folding boxes in 1870 and there were over 800 patents on similar boxing machines simultaneous with the early sales of ready-to-eat breakfast cereals. Automatic glass blowing and tin can making machinery appeared by the turn of the century. Most of the elements of packaging mechanization were available in 1900.[22]

Certainly, the new freezing and drying technologies of the twentieth century required special packaging. Part of Birdseye's success was his design of packages suited for the quick freezing method. In most instances, new packaging materials better performed the essential purpose of protecting food. But packaging changed character becoming equally, if not dominantly, as important an aspect of retailing as it was in processing. Supermarketing marked the change.

In 1916, Clarence Saunders opened the first self-service grocery store, Memphis's "Piggly-Wiggly" markets. Customers passed through a turnstile to enter where they were free to examine for themselves the produce and packaged foods on shelves and in bins. The success of "Piggly-Wiggly" was incredible. Within six months, Saunders sold $114,000 worth of groceries at a retailing cost of only $3,400. His entire inventory turned over 39 times in the first year. And, just four years after starting, Saunders was operating 404 "Piggly-Wiggly" stores with annual sales of $60,000,000.[23]

Self-service created the need for better packaging as it eliminated the need for clerks in the store. In 1924, the Du Pont Company acquired the French rights to manufacture

the viscose film, "Cellophane." As a food wrap, "Cellophane" was far superior to the brown or translucent waxed paper then in use; it retarded moisture loss in fresh produce, leaving vegetables attractive to the customer's eye but beyond touch. Pre-packaging began with self-service.[24]

In 1930, Michael "King Kullen" Cullen opened a market in Jamaica, New York that equalled Saunders' experiment. Using a converted garage, without fancy decoration, Cullen stuffed the building with groceries and hawked himself as "The World's Greatest Price Breaker." He offered some items at cost and none above a 20 percent markup. Business ran at $10,000 a week--20 times the volume of an average market--as Cullen undersold his competitors by five to 20 percent. Saunders' self-service idea and Cullen's volume sales at discount prices were the essential elements of the supermarket. "King Kullen" was soon followed by other independent grocers--"Big Bear, The Price Crusher," "The Whale," "Giant Tiger," and "Great Leopard." In 1933, "Albers' Super Markets" in Cincinnati were the first grocery stores to use the term "supermarkets" in their name. Local and regional chains quickly took up the idea, as the number of supermarkets ballooned from one in 1930 to over three thousand in 1937. By 1953, there were 21,400 supermarkets doing more than half of the grocery business in the country. Better lighting, layout, refrigerated equipment, shopping carts, and displays gradually added "excitement" to the convenience of buying food. Indeed, supermarkets relied on excitement and convenience to stimulate impulse buying, and better packaging helped.[25]

In 1944, Ohio State University carried out a research and development project that led to fully integrated and mechanized prepackaging. The project's sponsors were A & P Stores, the Atlantic Commission Company (food wholesalers), Du Pont, Hussman Refrigeration Company, Ohio Boxboard Company, and both the Food Machinery Corporation and the Oliver Machine Company. The experiment showed how central warehouses could receive, wash, trim, sort, wrap, label, and price food ready for supermarket distribution. Packaging mechanization stimulated research for new forms and materials: aluminum trays (1948); "Mylar" (1950); polyvinyl chloride film (1958), and aluminum drink cans (1959). Per capita consumption of packaging materials rose from 412 pounds in 1958 to 591 pounds in 1971 and continued to rise.[26]

In 1979, American consumers spent $239 billion for food. Farmers received $77 billion; $162 billion went for marketing costs. After labor, packaging materials comprised the second largest expense for marketing--almost $20 billion. Paperboard containers and boxes--for shipping crates, sanitary containers, and folding cartons for dry foods--accounted for 40% of the packaging materials used. Metal cans--steel and aluminum--made up 25%; plastics, for wraps, bottles, trays, and jars, 15%; glass, 10%, and other materials, 10%. Clearly, advancements in packaging represented technological achievements in the food industry equal to new machinery, new types of food, or more economical forms of business organization. As one food industry economist commented "competition here (in packaged foods) is in advertising and promotion and in the ever-present threat that a superior new product by another firm will capture a large share of a market currently held." In truth, the product need not be superior to its package.[27]

In 1978, the U.S. Army Research and Development Command, the Continental Flexible Packaging Division of The Continental Group, and the Flexible Packaging Division of Reynolds Metals shared the Institute of Food Technologists' Industrial Achievement Award. The product of their combined efforts was the "retort pouch"--a flexible laminated package that combined the qualities of the metal can and the boil-in bag. The Institute said that the pouch was "perhaps the most significant advancement in food packaging since the development of the metal can," and it was probably so. The retort pouch had remarkable advantages. In sterilizing, the pouch took only half the time to reach high temperatures as cans or jars because of its thinner profile. Sterilization was quick and complete. Pouched foods did not require refrigeration and had a demonstrated shelf life of up to 10 years. It reduced "cooking" to simply boiling water or turning on a microwave oven. Pouch manufacture used significantly less energy than cans or jars. In both home and factory, storage of pouches took less room than most other kinds of packages. Its potential in the food system was enormous.[28]

Better forms or packaging, along with more convenient modes of transportation, new sources of energy, improved processing techniques, food additives and supermarketing have distinguished the twentieth century's food system but, perhaps as important as technological developments, has been the trend toward economic concentration among producers. Not counting the conglomerates that manufacture bread in addition to telephone equipment or ice cream and aluminum, the largest food companies in the United States in 1979 were Beatrice Foods, Esmark, Kraft, and General Foods. These four companies alone, all ranking in the top fifty of *Fortune*'s "500," accounted for 16 percent of the food expenditures that Americans put out in 1978. Their combined sales amounted to over $33 billion. Perhaps no more than 35 firms share more than half of the food sales in the United States. Such vast economic power in the hands of so few producers raised questions of whether the modern food corporation will remain subordinate to the market or whether it will determine it in the future.[29]

The opinions on what twentieth century food technology has done often run to the extremes, though not without truth. A manager of the Tri-Valley Packing Association wrote that

> it is no accident that the United States' supermarkets present consumers with an array of several thousand handsomely packaged food staples and specialities which are convenient, healthful, pleasant to use, low in cost and uniform in quality. Although United States' wage earners spend the smallest percentage of earnings in history on food, our greatest dietary problem is overeating--non-malnutrition, as in less fortunate areas. The development of food processing has been a major factor in liberating human energies for other achievements.

Food journalists Waverley Root and Richard de Rochemont, on the other hand, concluded

> were it possible to envisage in one great glob the totality of what is now eaten in a single day by our fellow-citizens, whether at home, in institutions, in fast-food joints or in expensive restaurants, and to judge it in the light of what the country has produced in the past, and what it might produce again, the word "garbage" would rise inevitable to mind.

About the only ground on which such writers can agree is that consumers need to be better educated about what they eat.[30]

A common theme that runs through much of the writing about the modern food system is the lack of choice now or prospectively facing consumers. Industry executives harp on the constrictions that government regulations and political "consumerism" create. "Food activists" give the impression that conglomerate corporations now decide what "we will be allowed to eat," implying a limited choice. Both views hit upon the hallmark of American civilization--the freedom of choice in a large society. In truth, how we nourish ourselves has never known wider choice, and perhaps therein lies an irony. Both eating and choosing what to eat are, partly, emotional experiences. Food abundance has led to an almost bewildering number of choices, to the extent that people can underrate or feel oppressed by the choices at hand. Few people take time to reflect that food technology in the twentieth century has given Americans a highly centralized food system and the possibilities of escaping it, if they choose to.[31]

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THE SCIENCE OF NUTRITION

BY

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Understanding of nutrition has evolved from primative concepts which progressed through superstition and food taboos, folklore, and philosophical views of food and other materials. Meaningful progress was not possible until chemistry and biology had advanced through the development of controlled experimentation as a rational basis for acquiring sound knowledge.[1,2]

The concept of a single aliment (nutriment) was held by Hippocrates (460-370 B.C.) and it prevailed in varying degrees until the beginning of modern chemistry in the last century.[3] This grossly erroneous concept disappeared with the performance of the meaningful feeding and physiological experiments with animals and the beginning of some understanding of the chemical nature of substances found in food.

In 1906, the basis for the correct view was put in focus by F.G. Hopkins. In a lecture, which has now become classical, he stated the following:

> The animal body is adjusted to live either on plant tissues or on other animals, and these contain countless substances other than proteins, carbohydrates, and fats. Physiological evolution, I believe, has made some of these well nigh as essential as are the basal constituents of the diet . . . . The field is almost unexplored; only it is certain that there are many minor factors in all diets, of which the body takes account.[4]

This crisp insight contributed to the consolidation and revision of thought but it was to be approximately a decade before the primary problem of nutrition became broadly recognized. A fertile advancement came in 1907 when E.V. McCollum at the University of Wisconsin decided, as he later stated, "to make an effort to solve the problem of what, in chemical terms, constitutes the minimum quota of chemical substances on which an animal can function normally."[5] This new beginning was put into perspective by McCollum in 1951 in his survey of progress in nutrition up to and including the first half of the twentieth century:

> The objective of learning the nature of every constituent of plant and animal tissues was admirable, but it was still more important to discover those substances, well characterized chemically, which a diet must provide in order to support the normal physiological needs of the animal. It was also necessary to determine the proportions in which these substances should be supplied to secure best results . . . . It was necessary to combine chemical studies with animal feeding tests in which basal diets, simplified as far as possible, were used . . . . These studies made it apparent that there existed nutrients of which chemists knew nothing at all and that these were not furnished by diets composed exclusively of the recognized classes of nutrients.[6]

This objective was a significant basis for the early development of McCollum's biological method of analysis and his systematic employment of rats in advancing the understanding of nutrition. Beginning in January of 1908, his was the first rat colony in this country to be maintained and used for experimental nutrition studies.[7] Through his method of biological analysis, for example, it was found that when rats were fed a single seed such as wheat, growth was not sustained. It was also found that combinations of various seeds without supplements were inadequate. It was demonstrated that a particular nutritional deficiency or combination of deficiencies in animals restricted to a food or food product could be corrected through supplementation with other foods, food products or, in some instances, with a specific chemical element such as calcium. During their first seven years of such research, McCollum and his associates conducted over 1,600 feeding experiments. The principal findings were published over approximately 10 years in 38 scientific papers.

Soon after 1908 other investigators began to conduct related studies. Among these the most prominent in accomplishments and leadership were Osborne and Mendel at Yale University and the Connecticut Agricultural Station and Sherman at Columbia University. Through a combination of innovatively applied chemical and controlled animal feeding experiments, many nutrients were discovered, requirements for some nutrients were estimated, and marked advances were made in determining the right combination of foods to achieve optimum complementarity. Also, during these first two or three decades of the century great advances were made in the development of biochemical methods and in understanding the nature of enzymes and metabolic processes. These were key advancements from which the science of nutrition evolved and matured.

A CROWNING ACHIEVEMENT IN THE SCIENCE OF NUTRITION: DETERMINATION OF INDISPENSABLE AND DISPENSABLE NUTRIENTS

Progress occurred in a variety of ways but, basically, it came through the use of controlled experiments with laboratory animals and application of various aspects of chemistry and biological sciences. From 1906 to 1935 all the commonly occurring amino acids were characterized as to whether they were indispensable or dispensable. From 1913 to 1948 all the generally recognized vitamins for humans and higher animals were discovered and chemically characterized. Before the middle of the century nearly all the indispensable inorganic elements so recognized at this time were discovered. In 1932 the indispensability of at least one polyunsaturated fatty acid was established. The first half of the century marked an enormous leap forward in establishing a rational basis for determining nutritional requirements. Thus the goal of McCollum and other pioneers was achieved in defining an adequate diet in chemical terms.

The most productive period in the identification and characterization of vitamins and inorganic elements was in the 1930's. Also in that decade the characterization of the nutritional significance of specific amino acids was culminated with the discovery of threonine, the last of the indispensable amino acids to be so characterized. For this and for much of the other advances in this area honor goes to William C. Rose and his colleagues.[8]

Since approximately 1950, through large funding of research, it has been possible to maintain human subjects in satisfactory health for at least several weeks on diets that are in all respects chemically defined. This requires both a great level of achievement in the identification and synthesis of the nutrients as well as in the determination of amounts of each required for the maintenance of good health.

This signal achievement is illustrated in the chemically defined diet employed by R.E. Olson and associates as

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shown herewith.[9]

A CHEMICALLY DEFINED DIET FOR A SEDENTARY ADULT MAN*

Name	Amount	Name	Amount
WATER	1800 ml	FATTY ACIDS	
		Trilinolein	5.0 g
MINERALS			
Ammonium acetate	20.8 g	BULK	
Calcium acid phosphate	5.0 g		
Sodium chloride	3.0 g	Cellulose	20 g
Potassium chloride	3.0 g		
Magnesium carbonate	1.0 g		
Zinc sulfate	50 mg	VITAMINS	
Ferrous sulfate	20 mg		
Manganese sulfate	10 mg	Ascorbic Acid	100 mg
Sodium silicate	10 mg	Vitamin E	20 mg
Chromium sulfate	5 mg	Niacin	20 mg
Nickel sulfate	5 mg	Pantothenate	10 mg
Sodium selenate	5 mg	Pyridoxine	3.5 mg
Copper sulfate	5 mg	Riboflavin	2.5 mg
Sodium fluoride	2 mg	Thiamin	1.5 mg
Sodium molybdate	1 mg	Vitamin A	1.0 mg
Stannic sulfate	1 mg	Vitamin K	0.1 mg
Potassium iodide	1 mg	Folate	0.1 mg
Sodium vanadate	0.1 mg	Biotin	0.1 mg
		Vitamin D	0.01 mg
		Vitamin B_{12}	0.01 mg
CALORIES			
Glucose	600 g		
AMINO ACIDS			
L-Leucine	1.1 g		
L-Methionine	1.1 g		
L-Phenylalanine	1.1 g		
L-Lysine	0.8 g		
L-Valine	0.8 g		
L-Isoleucine	0.7 g		
L-Tryptophan	0.3 g		
L-Threonine	0.5 g		

*Reproduced verbatim from Olson (*Nutrition Reviews* 36 [1978]: 164).

Through the chemical characterization of vitamins, amino acids, and other nutrients, it became possible for the first time in the history of man to synthesize or concentrate from natural sources virtually any amount of a nutrient in pure form. Thus man had the power to dose himself with massive amounts of specific vitamins and other nutrients regardless of the adaptability of the body to such encounters. Of course, with proper regard for physiological requirements, the specific nutrients could be used beneficially for various purposes such as in the meaningful fortification of selected foods. Through chemical technology and persuasive marketing, specific nutrients became common articles in the retail trade and individuals could readily purchase whatever they wanted. The latter development came largely in the third quarter of the century. Thus it has become important to be clear on the meaning of the terms and language used in the popular and professional literature on nutrition, foods, and diet in relation to health.

MEANING OF NUTRITION

Strangely, the word nutrition has a variety of meanings. This is because it is frequently used carelessly or to convey different meanings. Indeed, in 1972, the late eminent British authority, W.R. Aykroyd, wrote a two page essay on this very subject. Although this compassionate physician and scientist believed that trying to produce a widely acceptable definition "is wasting time at an almost impossible task," he properly insisted that nutrition is indeed a process. Abandoning the elegance of definition as in a dictionary, Aykroyd wrote:

> Nutrition means primarily human dietary requirements, the nutritive value of foods; disease and death due to faulty diet; field programs to improve the diets of groups of people; and the comparison between well-fed children of today, with their glowing health and excellent physical development, and children of fifty years ago.[10]

In 1979, R.E. Olson, editor of *Nutrition Reviews*, broadly articulated nutrition as:

> basically an ecologic science encompassing agriculture, agronomy, soil chemistry, food chemistry, food microbiology, and food toxicology. The relationship of food to health is part of physiology and includes the study of digestion, absorption, metabolism, function and utilization of nutrients. It is basically a health science and involves all branches of medicine.[11]

He emphasized that, concerning humans, nutrition is an interfacial science between ecology and medicine. It is central to agriculture both in the production of livestock and dairy and poultry products and in achieving good yields of farm crops.

Schneider and Hesla have aptly written that "Nutrition is a curious science." This statement can be further explained by stating: "Among the biomedical sciences it is probably unique in that although it has 'hard science' at its core, it has numerous linkages with some of the 'soft sciences,' and through them a very real contact with many aspects of the human condition."[12]

In all the plethora of definitions and discussions of what is meant by nutrition there is none that is basically more correct or timeless than the description by H.C. Sherman in the various editions of his notable book *Chemistry of Food and Nutrition*. In the sixth edition, in 1941, he wrote that for understanding it is necessary

> to deal with nutrition in . . . the life processes as chemically connected in known and fairly direct ways with the actual nutrients supplied by the food; but even this will be found, on the one hand, to involve both structural organic and physical chemistry and, on the other hand, to have many far-reaching relationships to the chemical control of the life process and to the resulting health and well-being of the individual and the race.[13]

Giving some amplification to this description, E.N. Todhunter has written that the science of nutrition emerged through

> physiology, chemistry, biology, pathology, microbiology, medicine, agriculture and animal husbandry, public health, food production and technology, and on the development of systematic terminology, analytical methods including biological assays, and sophisticated equipment capable of measuring minute amounts of nutrients such as the trace elements and vitamins.[14]

Thus, in responsible considerations of the science of nutrition, knowledge of the "hard science" aspect is vital. Ignoring such aspects leads to confusion and frequently it provides fertile ground for quackery and faddism.

The interdisciplinary nature of nutrition is obvious. It is equally obvious that becoming qualified to teach or to give advice in nutrition requires more than a deep interest in diet and health, augmented by the uncritical reading of books, magazines, and advertising written by individuals who are either not soundly trained in the science of nutrition or lack the integrity to act with forthrightness.

WHO ARE NUTRITIONAL SCIENTISTS?

It was once stated by a noted chemist that "chemistry is what chemists do." It should be stated that professional nutritional scientists deal objectively and knowledgeably with nutritional matters. The training may vary substantially in breadth and depth but, as recognized in the various definitions cited, chemistry and biology are central. Indeed, many credible nutritional scientists are essentially biochemists who have specialized in some aspects of nutrition. Such persons are commonly referred to as nutritional biochemists. Physicians who have specialized in nutritional aspects of medicine can generally be designated as clinical nutritionists.

A nutritional scientist with strong basic training in chemistry and biology and who has "conducted and published meritorious original investigations in some phase of nutrition and who is presently professionally active in the field of nutrition" may be qualified for election to membership in the American Institute of Nutrition (AIN). The standards for selection are indeed discriminating and with only rare exception the background must include demonstrated achievement in conducting significant research.

Members of the AIN who have "conducted and published meritorious investigations in clinical nutrition" may be considered for election to the American Society for Clinical Nutirtion. This society is the clinical division of the AIN. Membership in one or both of these professional societies is a significant indicator of reliability in dealing with problems of nutrition.

The terms nutrition expert, nutrition specialist, and nutritionist have been meaningfully used since approximately 1930. However, they are frequently applied to persons whose interest and persuasiveness in nutrition far exceed their training and competence. This is of much importance when the designations undeservedly aid such persons in attracting a popular or professional following.

Exploitation or misguidance of credulous persons is frequently the consequence of such careless or purposefully incorrect identifications. For example, on the noted Johnny Carson Show in 1973, the late and well-known faddist, Adelle Davis, was referred to by Mr. Carson as a "famous nutritionist." In the same year the noted writer, Norman Cousins, in writing a newspaper column about nutritionists and the Food and Drug Administration, made particular reference to Miss Davis and lauded her as a "prominent nutritionist." This paragon of responsibility in the press attributed to her by this description a professional status, thus misleading the public. In like manner other pseudonutritionists or faddists profiting from similar careless identification are given credibility.

Nutritional scientists who merit that designation are well trained in basic sciences and in nutrition and they write and speak responsibly. They also consider all the evidence rather than selectively using only the literature reports and anecdotal claims that support a particular point of view.

Trustworthy popular writers in nutrition include Jean Mayer, R.M. Deutsch, and F.J. Stare. The most eminent and responsible early writer and shaper of public thought on nutrition was E.V. McCollum. In 1916, three years after his discovery of vitamin A, he began to inform the public through appropriate channels of the breakthrough discoveries in experimental nutrition. From 1922 to 1946 his major popular writings were published in *McCall's Magazine*. They were so basic and sound that many could be justifiably reissued today.

McCollum also greatly affected the dissemination of the newer knowledge of nutrition among physicians, dentists, dieticians, and nutritionists through his books *The Newer Knowledge of Nutrition* and *Food, Nutrition and Health*. The latter was non-technical. There were five editions of each. In keeping with his responsibility as a nutritional scientist, the non-technical book was produced, as he wrote, to help neutralize

> . . . . the exaggerated claims of advertisers of ordinary food products and the faddists and graceless exploiters of nostrums, those seeking to exploit the common nutrients as medicines, and other self-appointed advisors on subjects relating to health.[15]

The responsible performance of this great pioneer in the science of nutrition is being emulated by various other nutritional scientists, but frequently public self delusion and lack of understanding of science in advancing knowledge cause their recommendations and actions to be ignored or muted. There is great need for the public to be critical in seeking and accepting advice on nutrition and dietary practices.

CREDENTIALS IN SCIENCE AND NUTRITION

Credible nutritionists, dietitians, and others who advise in nutrition have scientific backgrounds. They keep in touch with recognized professional societies and colleagues and they "keep up" in part by reading books, journals, and other literature published with appropriate safeguards for scientific soundness and reliability. They keep productively involved in their professions.

The significance of professional credentials and professional organizations of integrity in nutrition is illustrated by some of the circumstances in the founding of the first scientific society and periodical in this country devoted exclusively to nutrition. They are the American Institute of Nutrition and the *Journal of Nutrition*. The journal was founded in 1928 and the new society was organized in 1933. The society is now to nutrition what the American Chemical Society is to chemistry and the American Dietetic Association is to dietetics. In stimulating his professional colleagues thoughout the country to join him in the establishment of the new scientific society, in 1932 the noted pioneer in nutrition, John R. Murlin, wrote:

> Preventive medicine based on the preservation of the live man through sanitation and nutrition is only the beginning. Our science makes a broad appeal, for everyone must eat. But there is an enormous lot of misinformation being bandied about under the name of Nutrition. A strong society, with high qualifications, will tend to restore Nutrition to a science.[16]

The goal of professional nutritionists is still the advancement of the science of nutrition and its application to the welfare of man.

RECOMMENDED DIETARY ALLOWANCES (RDA'S)

One of the great landmarks in the advancement of nutritional science was the development of substantial experimental and clinical information on the intakes of specific nutrients at different levels and in relation to the health status of the subjects. Using various criteria to evaluate the relationships, by 1940 it became possible to

make reasonable value judgments on the amounts of certain nutrient intakes needed by individuals to meet the requirements for good health. By 1943 the Food and Nutrition Board of the National Academy of Sciences had surveyed the evidence and published the first edition of *Recommended Dietary Allowances* for the purpose of "providing standards to serve as a goal for good nutrition." In the meantime, at approximately five year intervals, the ongoing process of evaluating information has resulted in the publication of a revised edition. The ninth edition will appear in 1980.[17]

The estimates are based on thoughtful and objective analysis of all the evidence that is available concerning human requirements for those indispensable nutrients on which there is enough knowledge to warrant evaluations. The estimates purposefully exceed the apparent requirements of most individuals to ensure that they are high enough to meet the needs of those with unusually large requirements. However, they do not necessarily cover the special requirements, either high or low, that may occur owing to genetic imbalances, infections, marked dietary imbalances, metabolic disorders, or other abnormalities that require special dietary management. When such dietary management may be useful, it is far better to have the guidance of professionally trained and objective nutritional scientists or clinicians than "would-be experts" who may or may not be motivated by pecuniary or ego interests. When there is lack of objectivity misinterpretation or rejection of RDA's generally occur.

LABELING FOOD PACKAGES

In the early 1970's the number of nutrients that could be covered by *Recommended Dietary Allowances* had become large enough to permit the initiation of informative food labeling procedures. For that reason and others extensive federal labeling requirments were instituted.[18] In essence, the Food and Drug Administration specified that the "Inclusion of any added vitamin, mineral, or protein in a product or of any nutrition claim or information, other than sodium content, on a label or in advertising for a food subjects the [food] label to the requirement of . . . nutrition labeling."

Thus the RDA milestone in the advancement of sound nutrition presents various aspects. One is the presumption in some places that knowledge of specific nutrient requirements expressed in quantitative terms on food lables can be dealt with safely and beneficially by average individuals in selecting their food and planning their diets. This is questioned bysome professional nutritionists because common knowledge of nutrients, nutrient distribution in foods, and nutritional processes is at best low and misconceptions are high. This is indirectly supported by the findings in a wide-ranging federal survey conducted in 1969.[19] For example, it was found that over one-third of the American people have various fallacious concepts of weight control. A very significant proportion approached health problems by trial and error, rather than with a grounding in belief or facts. The survey showed that three-fourths of the public believe that vitamin supplements provide more "pep and energy." Thus it is questioned whether the common use of detailed nutrition information on many food packages can actually encourage the selection and use of more healthful and economical foods. Perhaps the focusing on specific nutrient requirement in this manner creates notions that quantity of recognized nutrients is more important than a good selection of foods with high supplementary value. Thus in this frame of mind the individual may erroneously accept belief in "super health" and attempt to gain it through the use of excessive amounts of some nutrients. This is an important problem that ironically has been created by scientific advances in the knowledge of nutrition and the lack of adequate advances in public understanding.

There are obvious advantages to the current regulations and practices in food labeling, but there will always be harmful and uneconomical aspects as long as the public remains so lacking in basic knowledge of science and the principles of healthful living. It is necessary to recognize that the public welfare will be served through the science of nutrition and not through the pseudoscience and even antiscience that fascinate such a significant proportion of the population.

MEGAVITAMIN ERUPTION

Zealous advocates of high dosage levels for various nutrients have in general held the RDA guidelines in disdain. In doing so some have greatly exaggerated the fact that some "biochemical individuality" exists throughout all populations, thus leading large numbers of individuals to supplement their diets with large intakes of vitamin C, vitamin E, niacin, zinc, or whatever they are persuaded may be needed to satisfy unusually high requirements they may have.

At best, this is an illogical response since such practices should not occur unless there is sound medical evidence that the individuals in question indeed have abnormal requirements, or that a pharmacological benefit may be obtained that is greater than any risk that can be anticipated.

The emphasis on megavitamin and orthomolecular therapy has existed for more than a decade and it promises to continue since it rests on a body of assumptions and anecdotal observations that generally have great appeal. In 1973, the Task Force on Vitamin Therapy in Psychiatry of the American Psychiatric Association reached the following conclusion:

> The theoretical basis for megavitamin treatment especially with nicotinic acid has been examined and found wanting. . . . under these circumstances this Task Force considers the massive publicity which they promulgate via radio, the lay press and popular books, using catch phrases which are really misnomers like 'megavitamin therapy' and 'orthomolecular treatment' to be deplorable.[20]

In the meantime there have been no scientific developments to warrant any revision of this conclusion.

OVERVIEW

Contrary to the opinions of some scientists and others in the mid 20th century, the apparent solution to the problem of defining an adequate diet in chemical terms and the eradication of prominent deficiency diseases did not mark the end of challenging needs and discoveries in nutrition. This signal achievement made possible fruitful attacks on many problems, many of which are less obvious than such nutritional diseases as rickets and scurvy.

One area of widespread developemnt is in the engineering and formulation of new foods to meet a variety of needs. As pointed out by Sarett, these include diets for infant feeding, tube feeding, hyperalimentation, renal disease, genetic defects, and a host of other medical problems.[21] Without the basic knowledge on indispensable nutrients such developments could not occur. In utilizing new and chemically defined dietary formulations new discoveries are being made that increase man's ability to adapt to changing environmental situations. With the increasing capability in meaningful food engineering and the attendant increase in variety of foods as well as the availability of specific nutrients, basic public knowledge of nutrition is urgent.

Darby has suggested that such needs "can be met by incorporating (sound) nutrition information into all levels of formal education."[22] He has rightly advocated the provision of nutrition education for all teachers or teachers

in training. Of course, as he stated:

> A high priority should be given by colleges, universities, state and federal educational departments for support of nutrition education of professionals, paraproprofessionals, physicians, dieticians, public health nutritionists, dentists, nurses, veterinarians, social workers, physical education workers and health educators.[23]

Without improvement in general public understanding of nutrition, and the basics for good health, faddism and quackery will continue to flourish. As advocated so extensively by McCollum early in this century in his publication *The Newer Knowledge of Nutrition*, we need to adopt, in his words, "The use of foods for the preservation of vitality and health."[24]

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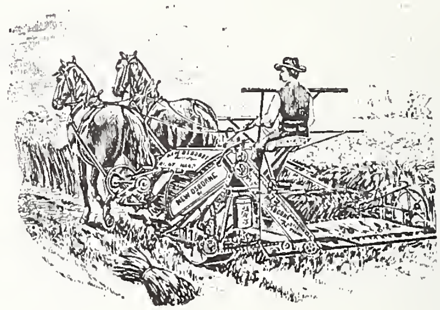

The "New Osborne Twine Binder" from a broadside by H.F. Mann entitled American Inventions Harvest the Grain of the World; The Old and New in Harvesting Machines, *1894 (Courtesy, Rare Book Collection, National Agricultural Library).*

SOCIAL FACTORS IN THE DEVELOPMENT OF NUTRITION STUDIES: 1880 - 1920

BY

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In considering the topic "Technology, Nutrition, and the American Food Supply," it is important to keep in mind the intimate relationship between science, technology, and society. The dramatic changes that technology has made in our ways of life are easy to see. The effect of social and economic factors in the development of scientific ideas is less obvious, but as equally important. This article shows how social circumstances influenced the course of human nutrition research during the early decades of the discipline.

The years 1880 to 1920 offer an excellent opportunity to study the relationship between social factors and the history of scientific ideas about food and nutrition. This time span can be divided into three periods: 1) the transition from animal feeding experiments to human nutrition studies (prior to 1885); 2) early efforts to determine human protein and caloric requirements (1885-1905), and 3) the opening of the era of vitamin research (1906 through World War I). Specific scientific problems and a particular set of social contingencies dominated the discipline during each of these phases. The most important social factor was the institutional setting in which scientists worked, but the general historical milieu was also significant. Each of these periods will be examined in turn and some general conclusions drawn about social influences on nutrition research.

I. The Transition from Animal Feeding Experiments to Human Nutrition Studies

"Before the last quarter of the nineteenth century . . . most Americans thought the only way to divide up food was with a knife and a fork,"[1] wrote Richard O. Cummings, foremost historian of American food habits. Scientific knowledge of the biochemical properties of foods and their effect on human physiology is a relatively recent phenomenon. Pre-industrial peoples never dreamed that their dinner of bread and meat contained proteins, carbohydrates, and fats, all supplying a measurable number of calories, plus vitamins and trace minerals.

How did scientific work on nutrition begin? The technical and economic conditions of industrialization fostered progress in chemistry during the eighteenth century. Early chemists investigated the principles of chemical composition, analyzing any and every substance they encountered. During the eighteenth and nineteenth centuries, traditional arts such as weaving, brewing, and baking were being transferred from home to factory. Mass production raised new technical problems; chemists directed their studies toward solving these practical difficulties. In 1839 the German chemist Liebig prepared a report for the British Association for the Advancement of Science entitled "Chemistry and Its Application to Agriculture and Physiology." The report outlined the foundations of a new subdiscipline, agricultural chemistry, specializing in the study of soils, fertilizers, and animal feeds.[2] Agricultural chemistry is the direct forebearer of the science of human nutrition.

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Agricultural chemistry was a practical science designed to increase the profits of the commercial farmer. The underlying idea, which differed dramatically from the orientation of the traditional family homesteader, was to manage the farm like a factory. As Boussingault, an early French agricultural chemist, put it:

> The whole object is the best system of husbandry to make the earth produce the largest quantity of organic matter in a given time.[3]

Agricultural chemists conducted animal feeding experiments to determine how to maximize meat amd milk production while minimizing the cost of livestock rations.

Human nutrition studies grew directly from such animal feeding investigations. In the 1880's the German chemist Carl Voit began to apply the principles of livestock management to the human diet, with one significant difference. In raising cows and pigs the criterion of success is maximum output of milk and meat for the minimum investment in fodder. The marketability of a human being, however, depends upon his muscle power, not his muscle tissue. Voit's studies emphasized the basic food requirements necessary to maintain the work capacity of industrial laborers. In either event, the rule for success was the most output for the least input.

The notion of an input/output ration reflects both the technical and commercial expansion characteristic of this early industrial era. On the one hand, the input/output ration is a mechanical concept, an engineering formula for calculating the efficiency of an engine. On the other hand, it is also a synonym for the profitability of investments.[4] The accountant balanced income and expenses in the same way that the engineer computed efficiency. These activities were historically linked because industrialization was not merely a matter of technological innovation. It also required the development of a capitalist system of economic production in which production for profit dominated over production for use. The traditional housewife and farmer simply want to feed and clothe their family with a little left over to trade for luxuries. In contrast, the businessman systematically pursues the infinite expansion of his trade by continually reinvesting the profits he has made. The successful businessman must keep careful track of income and expenses, investing his funds where they will bring the greatest return. Industrial development is an epiphenomenon of this social process of capital accumulation. In sum, the growth of business enterprise fosters both sophisticated systems of accounting and technological progress.[5]

The historical interrelationship between these mechanical and economic ideas was essential to the evolution of the scientific concept of metabolism. Metabolic studies conceived of the body as an engine, calculating the amount of fuel and oxygen necessary to keep its vital functions running. Nineteenth century metabolic investigators saw themselves as physiological accountants. In the words of Wilbur O. Atwater, a pioneer American nutritionist, scientific studies of digestion, assimilation, respiration, and excretion, balanced "the daily income and expenditure of the body."[6] For these reasons, medical historian George Rosen argues that "only in a society where such concepts prevailed could the idea of metabolism as an exchange of material and energy evolve and be successfully pursued."[7] The nutritionist used the calorie as his unit of calculation, the same unit the engineer used to measure the work of a machine. This abstract unit of calculation was easily converted to the terms of an accountant's equation--dollars and cents. Thus the first students of human nutrition were efficiency experts of a sort, estimating ways to fuel the human machine as economically as possible.[8]

Thus far, I have shown how the general intellectual orientation of human nutrition studies arose out of the social context of thriving commercial and industrial expansion. The history of scientific endeavor, however, is more than just a history of ideas; it is also the history of the men and women who practice science and the institutional context in which they carry out their activities. Science is a social enterprise. Perfectly good scientific ideas may disappear forever if there is no professional network to carry them

on.[9] The following section shows how the earliest American nutritionists, working in a society in which there was virtually no support for basic scientific research, built social institutions within which they could carry out their projects. The focal point for this discussion is the career of Wilbur O. Atwater, the first American to undertake human nutrition studies. This example underlines the relationship between the social milieu and the direction of scientific studies.

Wilbur Olin Atwater Nutrition scientist (Courtesy, U.S. Department of Agriculture)

II. Early Efforts to Determine Human Protein and Caloric Requirements

Until the late 1890's, the history of American research on human nutrition is virtually one and the same as the history of W.O. Atwater's career. As a graduate student at the Sheffield Scientific School of Yale University, Atwater was the first American to use the up-to-date methods of chemical analysis of foodstuffs which had been recently developed by German agricultural chemists. In 1873 Atwater was appointed professor of chemistry at Wesleyan University in Middletown, Connecticut, a position he held until his death in 1907. Five years later he was named first director of the Storrs. Connecticut Agricultural Experiment Station; from 1888 to 1894 Atwater headed the newly created federal Office of Agricultural Experiment Stations. Although he contributed much to the study of soil, fertilizers, and animal feeds, as well as to the institutional development of the agricultural experiment station concept, Atwater's foremost interest was the problem of human nutrition. This led him to undertake extensive postgraduate training in Munich with Carl Voit, whose pioneering studies of the diet of the German people he greatly admired. Atwater spent the rest of his life applying Voit's principles to the American context and building on the research foundations his mentor had laid.[10]

Atwater's foremost ambition was to accurately determine human requirements for protein and energy. The respiration-calorimeter, a device for directly measuring human metabolism, "the daily income and expenditure of the body," was the culmination of his life's work. While perfecting the techniques of respiration calorimetry, he followed Voit's example, carrying out extensive dietary surveys among the American people. Like Voit and his colleagues, Atwater assumed that if he studied enough people the statistical norm for the population would accurately reflect the physiological requirements for human food intake.

Atwater conducted the first U.S. dietary survey in 1884, under the auspices of the Massachusetts Commissioner of Labor, Carroll D. Wright. The result was published as part of a report on the costs of labor and living in Massachussetts. The diets of typical people, mostly factory operatives, many of them living in boarding houses, were studied. The investigators went to each household, measured the amount of food in the pantry, and recorded any additional food purchased during the ensuing two week period. Unedible refuse and table scraps were also accounted for. At the end of the field study the total amount of food consumed by the household was calculated in terms of its nutritional components: grams of protein; carbohydrates; fats, and total calories.

Atwater and Commissioner Wright developed co-efficients to estimate the differential consumption of each household member. A moderately active man was a single unit. An adult woman or a boy 14-16 years of age were assumed to eat 0.8 as much as an adult man. A child 6-9 years of age was computed as 0.5, a child under two as 0.3. This formula was used to convert total household nutrients purchased, from which the amount of waste had been subtracted, to nutrients consumed per moderately active man unit per day. Based on this data, Atwater concluded that a man at moderate work needed 125 grams of protein and 3,500 calories each day.[11]

This methodology points once again to the importance of social and economic factors in the development of nutrition research. In fact, Atwater's figures more accurately reflected the prevailing level of wages than any true physiological need. After all, the amount of food a family has to eat depends upon the wages of the breadwinner(s). During the nineteenth century, the majority of the people had no discretionary income; the average family spent 50 percent of its earning on food. If they earned less, they simply ate less.

Comparing his results with those of Voit and other European investigators who had concluded that a man at moderate work required 118 grams of protein and 3,050 calories daily, Atwater realized that the discrepancy between the two estimates was social rather than physiological in origin. First, land was more scarce in Europe, food was more expensive, and wages were lower. Second, Atwater believed that the American standard of consumption represented a biological and spiritual ideal which would "make the most out of man . . . bring him up to the desirable level of productive capacity . . . enable him to live as a man ought to live."[12] Although he expressed reservations about the amount of fats and sugar Americans consumed, Atwater privately feared that lowering the caloric standard accordingly might be interpreted as an attack on the average American working man's standard of living.

During the period of his career in which he concentrated on dietary surveys, Atwater was a scientist without a scientific institution. Although he retained his chemistry professorship at Wesleyan University, his USDA position as Director of the Office of Agricultural Experiment Stations, and his prestige among agricultural chemists and farmers, his human nutrition research had no official home. Atwater scrounged money and resources for these studies. Certainly he could never have carried out his research plans if enthusiastic women had not donated their labor to his cause. Home economists, women's clubs, and settlement house workers volunteered for the "nitty gritty" work of the dietary surveys, interviewing families, inventorying pantries, and collecting food specimens for laboratory analysis. Wesleyan University and the Storrs Experiment Station supported some of the work, but most of the funding came from the U.S. Bureau of Labor and from private philanthropies. These donors were interested in the work for its practical social implications rather than for its intrinsic scientific interest.

Atwater's most vociferous patron was Edward A. Atkinson, a Boston businessman who was active in contemporary public affairs. Wealthy, commanding presitge in the business community as an authority on cotton manufacturing and fire preven-

tion, Atkinson exerted considerable influence in the halls of congress and among presidential advisory committees.[14] He argued that the federal government should appropriate money to establish food laboratories in conjunction with the agricultural experiment stations. He appealed to the fiscal sense of the good businessman, arguing that this investment would assure national prosperity by enhancing the industrial efficiency of the population:

> If it is a sound policy for the Government to appoint a commission to determine how to lessen the waste of our store of coal, from which we derive mechanical power, it is surely as sound policy to spend a little money for the prevention of the waste of human energy, viz., the waste of our food supply. The causes of waste are to be looked for in special directions. In the case of the steam engine, it is in the imperfect combustion or waste of coal. The waste of human energy is to be found in the misuse or waste of food by bad cooking. Improper cooking not only causes a waste of energy, but is injurious to the machine itself in which the energy is produced; it is the cause of disease in the human body.[15]

In 1894 Congress appropriated $10,000 "to enable the Secretary of Agriculture to investigate and report upon the nutritive value of various articles and commodities used for human food, with special suggestion of full, wholesome and edible rations, less wasteful and more economical than those in common use."[16]

Many prominent citizens thought that nutrition research could help to solve the social problems of the newly industrializing cities. Immigrants poured into the cities, living in overcrowded tenements, and working long hours for low pay. Cycles of inflation and depression exacerbated these problems. There were frequent strikes, including some violent clashes between strikers and the militia, as workers struggled for higher wages and a decent standard of living for their families.[17] Some seized on nutrition research as a panacea. Scientific principles of nutrition would show workers how to market wisely and fill their food needs cheaply. Then they could use the money they had saved for better housing and the amenities of life. A perfect solution--if workers shopped and prepared food according to this plan--it would be like having a raise but employers would be spared the costs of wage increases. Trade unions were suspicious of this idea convinced, propably correctly, that it detracted public attention from the central issue--fair wages.[18]

Whether Atwater actually believed that nutrition research could fulfill the fervent hopes of its philanthropic supporters is unclear but there is no doubt that these expectations influenced his research. In his view nutrition was a social science; the "pecuniary economy" of food was as much the rightful domain of his discipline as was analytical and physiological chemistry. The most important scientific outcome of this orientation was the overemphasis on caloric requirements and the neglect of the accessory food factors (now known as vitamins and minerals) which contribute so much to nutritional well being. The value of citrus fruits and fresh vegetables in the prevention of scurvy had been recognized since the mid-eighteenth century when Lind performed his famous experiments for the British Navy. In addition, there was much traditional folklore about the tonic effects of spring greens and other fresh foods. Evidently, Atwater was ignorant of Lind's work and scornful of what he considered to be folk superstitions. In any event, fresh fruits and vegetables did not fit his ideas of good nutrition. Since they provided few calories and almost no protein, he considered them a waste of money, a luxury only the well-off could afford. As a result, Atwater not only lost a significant opportunity for scientific research but also he did a great disservice to the poor by arguing that their poverty was their own fault because they "wasted their money on fresh fruits and vegetables."

By the time Atwater died in 1907, the sources of institutional support for nutrition research were beginning to change. Scientists were no longer exclusively dependent upon philanthropists and the United States Department of Agriculture. For example, the Carnegie Institution, a foundation devoted to the support of pure science, had assisted Atwater with his respiration calorimeter experiments. Shortly after his death, the Carnegie Institution opened a nutrition laboratory, appointing Atwater's assistant, F.G. Benedict, as director. Despite this significant advance for basic research, most American nutrition investigators worked in the agricultural experiment stations, and their work continued to be influenced by the demands of this environment.

III. The Opening of the Vitamin Research Era

The pressure for practical results served as a spur to progress in certain areas of nutrition research, such as animal feeding experiments, metabolic studies, and the collection of data on the dietary habits of various human populations. Yet this same pragmatism made scientists prone to overlook the more subtle nutritional properties of foods, the class of nutritive components now known as vitamins. By 1905 agricultural chemists were approaching a dead end in their empirical investigations. Accepted theory held that foods were composed of proteins, carbohydrates, and fats, along with some minerals. Therefore, purified proteins, carbohydrates, and fats, if fed to experimental animals in correct proportion and sufficient quantity, should be adequate to support life. However, reports of experiments in which the animals died when fed exclusively on purified food components were scattered throughout the scientific literature. Most scientists assumed that the laboratory food was so unpalatable that the animals didn't eat enough and starved to death. A few thinkers, most notably the English biochemist, F.G. Hopkins, speculated on the existence of "accessory factors" in food as minute quantities of some substance chemically different from proteins, carbohydrates, and fats but just as essential.[19]

This section shows how two aspects of the social organization of nutrition research impeded early efforts to explore this new concept. These social factors were: 1) the demands of the agricultural experiment station, and 2) the long-standing separation between nutrition and medicine. The experiment station put a premium on practical results. Experiment station directors discouraged their staff from projects which had no immediate agricultural applications, since farmers thought such foolishness a waste of public funds.[20] As a result, most nutrition researchers used farm animals for their studies and emphasized visible results, such as weight gain, rather than exploring the subtle effects that nutrition has on health and well-being. In addition, chemists had no training in pathology, so even when they were looking, they often missed the inconspicuous and seemingly unrelated symptoms that characterize vitamin deficiency states. For example, Lafayette Mendel and Thomas Osborne, working at the New Haven experiment station, assumed that their rats had contracted conjunctivitis, an eye infection which spreads easily among closely confined animals. In fact, they had observed, and dismissed as irrelevant, eye damage caused by vitamin A deficiency.[21]

Working in experiment stations, agricultural chemists rarely had contact with physicians who might have helped them with these problems. Doctors not only worked in different places than did nutrition researchers, they also had different scientific interests. Reaping the technical successes recently derived from the germ theory of disease, physicians were indifferent to notions that diet, apart from literal starvation, might play a role in health and illness. Although deficiency diseases--notably scurvy--had first been described by physicians, medicine had abandoned the idea by the time biochemical researchers were ready to pursue it.[22] The following anecdotes, taken from the memoirs of E.V. McCollum, the biochemist who identified vitamin A, and Joseph Goldberger, the public health physician who demonstrated that pellagra is a deficiency disease, illustrate the effect that these social factors had on their scientific work.

McCollum's account of his early work on vitamin A, conducted at the Wisconsin College of Agriculture's Experiment Station, shows how experiment stations encouraged work considered of practical value while discouraging other pursuits. In 1907 McCollum was puzzled by the results of some cowfeeding experiments that he was working on with a colleague. The oat-fed livestock were healthy while those given an equivalent amount of wheat were undersized, blind, and incapable of bearing live offspring. Searching for clues to this mystery, McCollum reviewed all the literature, heretofore scattered and unanalyzed, on attempts to maintain laboratory animals on purified diets. This research convinced him that the only way to make any headway on the problem of what was missing in the wheat diet was to carry on systematic feeding experiments with small laboratory animals such as rats. First, since they eat very little, it would be easier to produce an adequate supply of the experimental rations which were so difficult to purify. Second, since rats have a short lifespan, McCollum could observe the long-term effects of the various diets in just two or three years.

McCollum presented his idea to the college dean, H.L. Russell, who refused to give him any money for his project. Farmers, said the dean, would be outraged if they discovered that the experiment station provided room and board for pests. McCollum paid for the laboratory rats and other costs himself. Luckily, a sympathetic maintenance man built the rat cages and a local woman, Marguerite Davis, served as full-time caretaker for the rat colony for five years without pay. The dean's decision was not merely an arbitrary one. Any other dean of an agricultural college would have acted the same way; in fact, Russell was probably more liberal in this respect than most. McCollum considered himself fortunate even to even be allowed to carry on his work independently.

The second telling incident occurred in 1913, six years after the initial confrontation with Dean Russell. McCollum's experiments with the rat colony indicated that some fat soluble substance, later identified as vitamin A, was necessary for health. Further studies showed that the substance was present in some fats and not in others; butterfat and egg yolk, for instance, proved far superior to olive oil and lard. The dean, who previously had merely tolerated the existence of the rat colonies the the experiment station, was delighted with the results. Butter and cheese were the backbone of Wisconsin's agriculture; McCollum postponed publication until he could complete the series of tests to his own satisfaction. This occasion was typical of the way science was conducted in these institutions at that time. The agricultural colleges were under constant pressure to prove that they were giving the American farmer his money's worth. To show evidence of productivity, experimental results were often published prematurely. Thus frequent retractions and corrections were necessary, making the accumulated scientific literature difficult to interpret.

Before turning to Goldberger's story, it is necessary to summarize the breakthroughs which occurred in nutrition research between 1912 and 1916. All of these laid the conceptual groundwork for the progress of vitamin research. However, this is more obvious in retrospect than it was to the scientific community at that time. Having observed that beri-beri, a disease characterized by paralysis of the extremities, occurred frequently among populations which switched from unprocessed to polished rice, several investigators managed to cure the victims with rice polishings and extracts from the polishings. In 1912 Casimer Funk published a groundbreaking theoretical paper in which he coined the term "vitamine" for the postulated accessory nutritional factors and showed how such substances might be related to beri-beri, scurvy, and pellagra. Although McCollum doubted whether he had found Funk's "vitamine," the fact that Osborne and Mendel, working in New Haven, had isolated the same fat soluble substance, confirmed that he had found something. Uncertainty as to whether there were one or several "vitamines" complicated the puzzle. McCollum soon distinguished a second essential substance in the rat's diet, water-soluble B. In sum, although vitamins were difficult to isolate chemically, their absence could be identified clinically; as a result, the theory of deficiency disease was established conceptually by 1916.[24]

A well-defined theory differs from a wisely accepted theory. Many nutrition researchers doubted the existence of vitamins; physicians were even harder to convince. Joseph Goldberger's experience shows the extent of this skepticism. In 1914, the U.S. Public Health Service sent Joseph Goldberger to Mississippi to investigate pellagra. The disease, which is characterized by skin lesions, gastrointestinal distress and, in severe cases, "black" tongue and mental disorganization, was endemic in the South. Pellagra was seasonal, breaking out in the spring and disappearing in the fall, and much more common in hard times than in prosperous years. It was presumed to be a contagious disease, probably transmitted by insects.

An expert in infectious diseases, Goldberger observed that in an orphanage in which 60% of the children were afflicted with pellagra, both the staff and the older children who had outside jobs seemed immune. Suspecting that only those children who were restricted to the institutional fare of grits, vegetables, and corn bread suffered the disease, Goldberger succeeded in eradicating pellagra at the orphanage by supplementing all the children's meals with meat, milk, and eggs. This was followed by experiments on prisoners in which Goldberger succeeded in inducing and curing pellagra through dietary changes. Most physicians, convinced that pellagra was an infectious disease, disregarded these results, accusing Goldberger of faking the experiments. In response, Goldberger and his colleagues "swallowed in capsules the most nauseating diabolical concoctions made up of secretions of blood, feces, and urine of pellagra patients" in addition to injecting themselves with the blood of pellagrins.[25] None of the subjects contracted pellagra. Despite this dramatic performance, physicians remained skeptical.

Although the social factors described above impeded the early progress of vitamin research, the outbreak of World War I created social conditions which counteracted this scientific inertia. This had important implications for scientific research on vitamins, the dissemination of information on vitamins, and American dietary habits. Up to that point Americans followed their traditional dietary patterns, eating mostly meat and potatoes or other starches and making little use of milk products or fresh fruits and leafy green vegetables. For the most part this reflected the cost and availability of foods though, to some degree, it reflected the legacy of Atwater's nutritional principles. Pioneering studies on vitamins pointed to the nutritional value of fruits, vegetables, and dairy products. McCollum coined the term "protective" foods to describe their beneficial effects on health.

Modern nutritional knowledge coincided perfectly with the United States government's war plans. There were severe food shortages in Europe, making it necessary for the U.S. to send supplies to its allies abroad. Staples, such as wheat, fats, and sugar were shipped overseas, while domestic consumption of perishables, such as fresh fruits and vegetables, increased. The United States Food Administration, constantly reminding the public that "Food Will Win the War," emphasized both the vitamin content of these foods and their strategic role in food conservation policy. Only a decade before the USDA had warned consumers that they were wasting their money if they ate tomatoes and oranges because fresh fruits and vegetables, while costly, contained little of the essential nutritive elements--calories and protein. During the war, it was a citizen's patriotic duty to eat tomatoes. The result was a rapid turnabout in nutritional common sense.[26] In sum, the First World War was the moving force in disseminating the "newer knowledge" of nutrition among the medical community and the general public as well as promoting further work on these ideas within the scientific community.

IV. Conclusions

This paper has shown the importance of social factors in the development of nutrition research during the period 1880 to 1920. The demands of the institutions in which nutrition investigators worked have, at different times,

both helped and hindered the pursuit of important scientific concepts. Most notably, the emphasis on practical applications, including notions of mechanical and cost efficiency which promoted the evaluation of human protein and energy requirements along with related metabolic studies, impeded the early exploration of "accessory factors" in food. The historical division between medicine and nutrition slowed both the scientific discovery of the role of vitamins in health and the dissemination of this information to the general public. Although, by 1907, some laboratories existed for basic research on nutrition, sometimes in association with medical schools, this alone did not significantly alter the long-standing social patterns of nutrition research. The global crisis of the First World War promoted rapid change in the direction of nutrition research. Ironically, this was not because military policy aided basic science but because it exploited the practical applications of existing knowledge. In this case, the vitamin theory was compatible with war-time food conservation strategies.

Do these observations have any contemporary relevance? There is some indication that they do. Arguments put forth by present day critics of national nutrition policy indicate that practical economic considerations continue to outweigh basic research on the role of nutrition in achieving optimal health.[27] Various observers have argued that nutritional needs take a back seat to marketability in food industry[28] and agricultural research[29] and that physicians are neither adequately trained nor sufficiently interested in the relationship between health, illness, and diet.[30] If these critics are correct, further study might very well show that similar, though undoubtedly not identical, social factors influence contemporary nutrition research.

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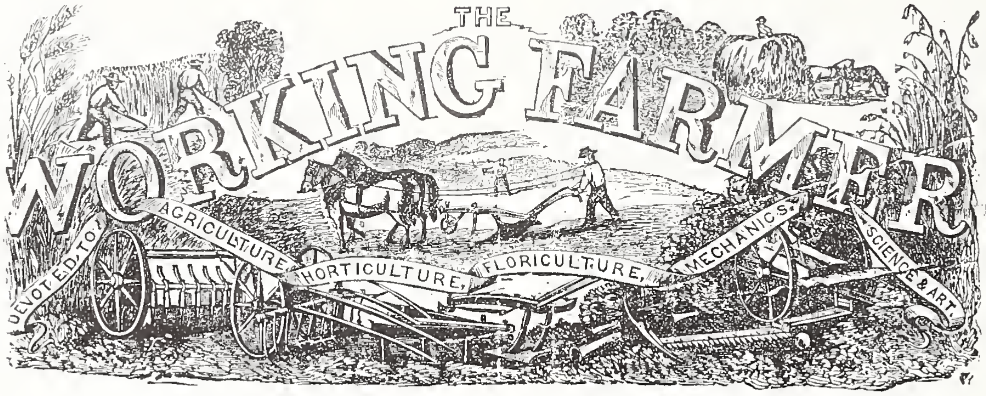
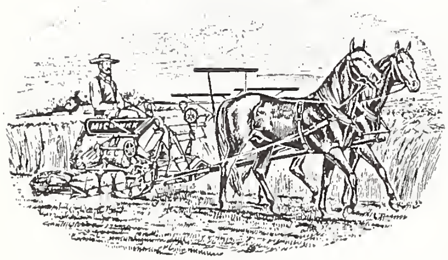
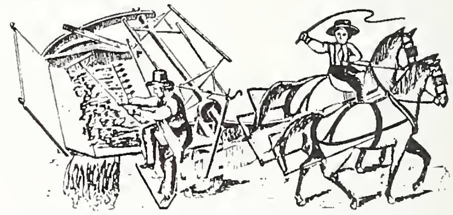
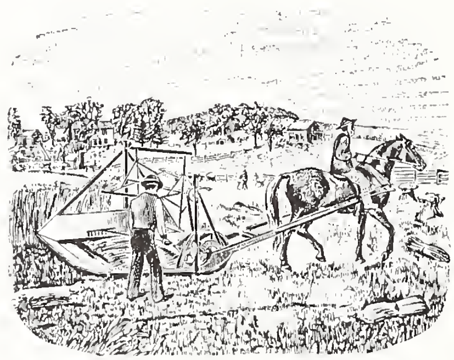




McCormick's Twine Binder, 1894 (McCormick Harvesting Machine Company, Chicago, Illinois; Successor of Cyrus H. McCormick).

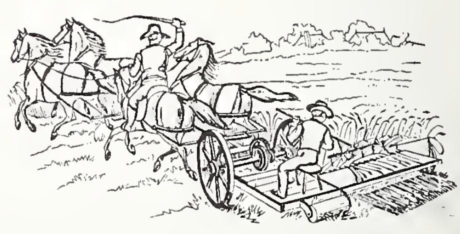


Hussey Reaper, 1833 (Obed Hussey, Cincinnati, Ohio).



McCormick's First Reaper, 1831 (Cyrus H. McCormick, Rockbridge, Virginia).

Buckeye Twine Binder, 1894 (Aultman, Miller & Company, Akron, Ohio).



McCormick's Reaper, With Raker's Seat, 1845 (Cyrus H. McCormick, Rockbridge, Virginia).

(The five illustrations are from a broadside by H.F. Mann entitled *American Inventions Harvest the Grain of the World; the Old and New in Harvesting Machines*, 1894 (Courtesy, Rare Book Collection, National Agricultural Library).

INFORMATION RESOURCES FOR FOOD SCIENCE AND HUMAN NUTRITION

BY

ROBYN C. FRANK*

Food is America's biggest business and employer. Farmers in the United States produce not only enough food for us but also enough to make large quantities available for international trade. In addition, there is world-wide concern over the relationship between diet and health. In the United States, this interest is signified by the publication of the *Dietary Goals*[1] by the U.S. Senate Select Committee on Nutrition and Human Needs, and the *Dietary Guidelines*[2] recently issued jointly by the U.S. Department of Agriculture (USDA) and the U.S. Department of Health, Education, and Welfare. Consequently, food and nutrition rank high along with inflation, energy, and the environment as one of the most important issues of our day.

Research findings are most generally disseminated through papers in scientific journals. The number of scientific and technical journals, as well as scientific papers published, has grown geometrically since 1900. The 1960's-1970's have witnessed the importance of retrieving relevant information from a vast array of sources. Computer technology has played a major role in making this information accessible. A growing number of information services exist which monitor the literature on food and nutrition, condense it into abstracts, and disseminate it in machine-readable form.

Libraries and specialized information centers are storehouses of information. Librarians and information specialists have access to documentation that has been sorted, filed, and tagged so that it can be retrieved easily. In addition to having access to machine-readable data bases, these information services usually have useful reference tools such as directories which can lead one to other helpful resources.

This paper concentrates on the machine-readable data bases and organizational resources that should be considered when seeking out food and human nutrition information. The 23 data bases highlighted are not all inclusive but they represent some of the most useful and generally recognized resources on this topic.

SUMMARY
PART I:
DATA BASES ON FOOD AND NUTRITION

Bibliographic:

Major Emphasis on Food and Nutrition	*In-depth Coverage of Selected Food and Nutrition Areas*	*Minor Emphasis on Food and Nutrition*
AGRICOLA	*BIOSIS*	*ASFA*
CAB Abstracts	*CA Search*	*CLAIMS*
FOODS ADLIBRA	*COMPENDEX*	*Comprehensive Dissertation Abstracts*
FSTA	*Excerpta Medica*	*Conference Papers Index*
	MEDLINE	*EPB*
		ERIC
		NTIS
		Population Bibliography
		SciSearch
		TOXLINE
		WPI

Referral:	*Numeric:*
CRIS	*USDA Nutrient Data Bank*
SSIE	

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PART I: DATA BASES

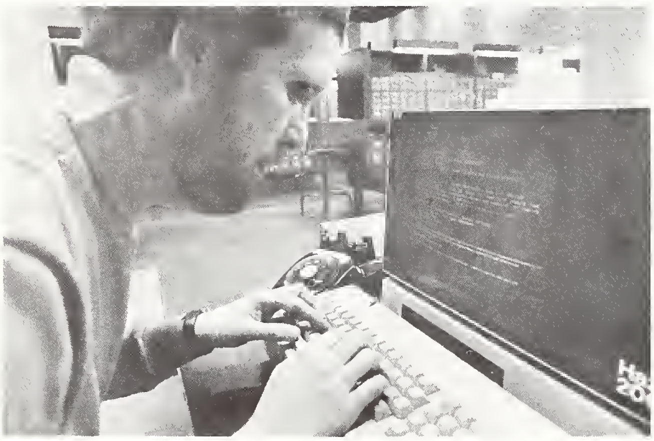
BIBLIOGRAPHIC DATA BASES

Major Emphasis on Food and Nutrition:

AGRICOLA

Produced by the U.S. Department of Agriculture, Technical Information Systems (the National Agricultural Library), the AGRICOLA data base contains citations to the world-wide literature on food and agriculture. The data corresponds in part to the printed *Bibliography of Agriculture*.

Works on various foods and food products comprise a major portion of the AGRICOLA file. The Food and Nutrition Information Center's subfile deals primarily with the subjects of human nutrition research and education, food service management, consumer protection, food and nutrition policy, U.S. nutrition programs, diet and diet-related diseases, physiology of human nutrition, food composition, and home economics.



William Feidt doing an online retrieval of the AGRICOLA data base at the National Agricultural Library (Courtesy, U.S. Department of Agriculture).

CAB Abstracts

The Commonwealth Agricultural Bureaux (England) produces the machine-readable counterpart to its 26 abstract journals covering the world-wide literature in the agricultural sciences and related areas of applied biology. The criteria for selecting material for inclusion in the data base are relevance and scientific importance.

Of particular interest to food scientists and nutritionists are the citations contained in CAB's *Nutrition Abstracts*. From 1973-1976, both human and animal nutrition were combined into one subfile of CAB Abstracts. Beginning in 1977, nutrition was divided into two major categories: (1) human and experimental, and (2) livestock feeds and feeding. Human and experimental nutrition now includes technique, foods, physiology and biochemistry, human health and nutrition, diseases and therapeutic nutrition, and book reviews and reports.

FSTA (Food Science and Technology Abstracts)

Food Science and Technology Abstracts (FSTA) is a product of the International Food Information Service (IFIS) which is a consortium composed of the Institute for Food Technologists (IFT) (USA), Geseleschaft fur Information und Dokumentation (GID), the Commonwealth Agricultural Bureaux, and the Dutch Agricultural Documentation Centre (PUDOC) of the Netherlands.

FSTA is the only data base dedicated solely to the subject of food science and technology. Four types of publications are covered: (1) primary journals; (2) patents; (3) standards, and (4) textbooks. Over 1,400 journals from more than 74 countries are scanned and abstracted regularly and these citations comprise approximately 84% of the data base.

Four subject areas dominate the total number of abstracts in the data base: milk and dairy products (13.11%); alcoholic and non-alcoholic beverages (11.68%); fruits, vegetables, and nuts (10.94%), and meat, poultry, and game (10.31%) providing over 46% of the total. The remainder is comprised of abstracts in the broad area of food science and technology per se and its relationship to other disciplines.

In the area of nutrition, the only documents included are those dealing with the biological testing of food additives involved in the manufacture of foods with a special dietary significance or with the general theme of the effect of processing on nutritive values. Quantity food production relating to the handling, processing, and storage of food in bulk and large-scale cooking of prepared foods are also included in the data base. Although technical or scientific coverage of the literature is very comprehensive, the file is not all inclusive of the trade literature in food technology.

FOODS ADLIBRA

A comparative newcomer to the field, *FOODS ADLIBRA* is a twice-monthly publication with a corresponding computer data base that began in 1974. *FOODS ADLIBRA* contains abstracts and information from nearly 300 trade, scientific, business, and government publications, the U.S. Patent Office's *Official Gazette*, and company, university, and association news releases.

Emphasis is placed on current information dealing with all aspects of the food industry. The majority of publications cited in a particular month are included in *FOODS ADLIBRA* issues dated in the same month. *FOODS ADLIBRA* provides particularly good coverage of food marketing, new food products, and news on the food industry. Other subject areas include nutrition and toxicology information; government, company, and association news; packaging developments, food commodities, news in general, and world food economics.

BIOSIS (Previews)

The BIOSIS files--the machine-readable counterparts of *Biological Abstracts* and *Bioresearch Index*--cover the world-wide literature of research in the life sciences. Included in this data base are citations from approximately 8,000 periodicals, monographs, conference proceedings, symposia, and research communications which are regularly screened.

Approximately 150 core journals in the fields of food technology and food and industrial microbiology are monitored on a regular basis which accounts, from 1975-1979, for over 20,000 citations. Seventy-six primary journals in nutrition are reviewed on an on-going basis which accounts, from 1975-1979, for almost 8,000 citations.

The BIOSIS files are useful in identifying documentation in the areas of food and human nutrition. Food technology covers the non-toxic studies that deal with food processing, food preparation, equipment and handling techniques, food preservation, biochemical and chemical reactions of food products or their ingredients; anti-microbiology includes the effect of viruses, bacteria, algae, fungi, and protozoa on food and industry.

Both human and animal nutrition are included under the subject scope of nutrition. More specifically, it covers the nutritional value of food, the therapeutic use of vitamins and other nutrients, and microbial assays of body fluids to determine nutritional deficiencies. Additional subject areas that can be searched of interest to nutrition include the digestive system and metabolism.

CA Search (Chemical Abstracts Service)

Corresponding to the printed version of *Chemical Abstracts*,

the CA files are particularly useful when searching for technical information. The section on foods covers technological aspects of food chemistry, including those chemical and analytical studies primarily directed towards the composition, preparation, and treatment of foods for human and animal consumption. Additional areas covered include: herbicide and pesticide residues on foods or food products; food preservation and packaging; application of microorganisms to food production; food additives; *Federal Register* items covering standards promulgated under the Federal Food, Drug, and Cosmetic Act pertinent to food; edible fats and oils, and methods for the determination of toxic contaminants of foods. Useful cross-references include the sections on animal nutrition, toxicology, organic as well as inorganic analytical chemistry.

The section on animal nutrition includes nutritional studies in all animal species, except protozoa, relating to vitamins, minerals, carbohydrates, lipids, proteins, and amino acids. Also included in this section are the following: the analysis of the nutritive value of foods and of nutritional balance and interrelations; nutrient requirements and utilization; energy values of food constituents, and diseases distinctly recognized as resulting from nutritional disorders, reversible starvation, and therapeutic diets. Clinical nutrition studies are not included in this data base.

In 1979, the CA computer file included nearly 9,000 document references in the Foods Section and nearly 6,000 in the section on Animal Nutrition. The CA files are unique in their indexing policy for chemical substances which make it possible to search using registry numbers as well as in-depth indexing terms. CA covers many journals not found in FSTA and the time between the original publications and its appearance in the printed or online version is relatively short.

COMPENDEX

COMPENDEX is the name for the Computerized Engineering Index which covers the world-wide literature (excluding patents) in engineering and technology. This data base is a good supplement to FSTA in food engineering issues due to its extensive coverage of engineering journals. Approximately 2,000 records are added each year to the data base in the field of agricultural engineering and food technology. Subject areas within food technology include food additives, food industry, food manufacture, food packaging, food packaging materials, food preservation, food processing, and food products.

Excerpta Medica

The Excerpta Medica data base contains citations and abstracts of biomedical and pharmaceutical information taken from more than 3,500 primary journals published world-wide. Human nutrition is covered in the areas of child nutrition, maternal nutrition, over-nutrition, food habits, nutritional deficiencies and nutritional status. The biochemical effects of food consumption plus works on the various nutrients themselves are also included.

MEDLINE

For questions regarding human nutrition in relation to disease as well as food microbiology areas, MEDLINE is a good data base to search. MEDLINE, which is produced by the National Library of Medicine, covers the medical literature beginning in 1966. Citations from 3,000 journals published in the U.S. and about 70 foreign journals are included in MEDLINE as well as references to chapters from selected monographs.

Minor Emphasis on Food and Nutrition:

ASFA (Aquatic Sciences and Fisheries Abstracts)

Producer: Food and Agriculture Organization (FAO) and the Intergovernmental Oceanographic Commission of the United Nations' Educational, Scientific, and Cultural Organization (UNESCO).

Food/Nutrition Content: Provides coverage on aquatic products used as food including composition and properties of primary and secondary edible aquatic products including physical, chemical, and nutritional changes to properties through storage, cultural practices, pollution, or additives, and spoilage, process engineering, processing technology, and quality control.

CLAIMS (U.S. Patents)

Producer: IFI/Plenum Data Company.

Food/Nutrition Content: Contains citations to U.S. patents including those related to food engineering and technology.

Comprehensive Dissertation Abstracts

Producer: University Microfilms International, Inc.

Food/Nutrition Content: Contains citations to all dissertations accepted for doctoral degrees by accredited U.S. academic institutions and over 125 non-U.S. institutions. Subject fields include food technology, nutrition, home economics, horticulture, and various agricultural topics.

Conference Papers Index (CPI)

Producer: Data Courier, Inc.

Food/Nutrition Content: Provides citations to scientific and technical papers presented to over 1,000 regional, national, and international meetings. Currently there are over 700 papers in the file on the general topic of food technology.

EPB (Environmental Periodical Bibliography)

Producer: Environmental Studies Institute.

Food/Nutrition Content: Contains citations to the literature on the environment including human ecology, nutrition, and health.

ERIC (Educational Resources Information Center)

Producer: U.S. National Institute of Education.

Food/Nutrition Content: Provides citations on child nutrition programs, foods instruction, nutrition education, food service management, career education, and training.

NTIS (National Technical Information Service)

Producer: U.S. National Technical Information Service.

Food/Nutrition Content: Contains citations for unrestricted technical reports from U.S. government sponsored research, development, and engineering projects. In addition, reports prepared by Federal agencies and their contractors or grantees are included. Food technology and food service are represented.

Population Bibliography

Producer: Carolina Population Center, University of North Carolina.

Food/Nutrition Content: Provides citations to the literature on the socio-economic aspects of population research and studies. The relationship of food/nutrition and population, nutrition and fertility, and the world food situation are covered.

SciSearch (SCI)

Producer: Institute for Scientific Information.

Food/Nutrition Content: Contains citations on food science and human nutrition and makes use of citation indexing. This type of indexing is based on the concept that an author's references to previously published material indicate a subject relationship between the current paper and the earlier citations in the bibliography.

TOXLINE

Producer: U.S. National Library of Medicine, Toxicology Information Program.

Food/Nutrition Content: Provides citations in all areas of toxicology.

WPI (World Patents Index)

Producer: Derwent Publications, Ltd.

Food/Nutrition Content: Contains citations to chemical patents issued by the patent offices in major industrial countries.

REFERRAL DATA BASES

CRIS (Current Research Information Service)

Produced by Technical Information Systems--USDA, CRIS covers research in progress sponsored or conducted by USDA research agencies, State agricultural experiment stations, State forestry schools, and other cooperating State institutions in those biological, physical, social, and behavioral sciences related to agriculture including food and nutrition.

Approximately 2,500 projects, currently in CRIS, directly relate to food science and nutrition. Another 2,300 projects can be considered indirectly related. In addition to project descriptions, CRIS citations also contain financial management data and citations to the publications generated from the project.

SSIE (Smithsonian Science Information Exchange)

SSIE is a multidisciplinary data base which covers basic and applied research in all areas of the life, physical, social and behavioral, and engineering sciences. Descriptions and references to research in progress and recently completed research sponsored by Federal government agencies, State and local government agencies, non-profit associations and foundations, colleges and universities, and foreign research organizations are listed.

Approximately 4,000 notices of research projects in the area of food science/technology are included. These notices are one page summaries of on-going research activities within the latest 24 months.

NUMERIC DATA BASES

USDA Nutrient Data Bank

For decades, USDA has been gathering nutrient data and tabulating them to produce handbooks of food composition. These handbooks have been available in machine-readable form for about 12 years. Presently, the nutrient data bank, a computer-based system for storing data on the nutrient composition of foods, is being utilized to revise Agricultural Handbook No. 8, *Composition of Foods--Raw, Processed, Prepared.* Data are processed by food groups and the revision is published in sections as each food group is completed.

Major sources of data are published research, the food industry, USDA's nutrient composition laboratory, special USDA projects which include nutrient analyses, and contracted research. Several food composition data sets are available to the public in machine-readable form.[3] These magnetic tapes include the food composition data as contained in Handbook 8, the data contained in Agricultural Handbook No. 456, *Nutritive Value of American Foods in Common Units*, issued in 1975, and the updates for Handbook 8. At this time these files are not accessible through the three major online vendors (Lockheed, System Development Corporation, and Bibliographic Retrieval Service) for online searching.

Access to Data Bases:

All of the data bases cited in this paper, except for the nutrient data bank, are available for searching via three major commercial information service vendors: Lockheed's DIALOG; System Development Corporation's Search Service, and the Bibliographic Retrieval Service (BRS).[4]

In most cases, costs for this type of data base service are based on an hourly connect-time rate, plus telecommunications costs for network access. Many university and research libraries subscribe to the various on-line services and provide search service to their clientele for a fee or at little or no cost.

USDA scientists have access to the Current Awareness Literature Service (CALS)[5] of Technical Information Systems, USDA. CALS provides selective dissemination of information (SDI) services from nine multi-disciplinary bibliographic data bases--including AGRICOLA, FSTA, CA, CAB, and BIOSIS--to more than 2,000 USDA researchers. On a regular basis, each of the preselected data bases desired is searched for pertinent citations based on the users "profile." The profile is a description of the subject area of interest using keywords or descriptor terms.

PART II:

ORGANIZATIONAL RESOURCES FOR FOOD & NUTRITION INFORMATION

Data bases are a significant resource for food and nutrition information, but they cannot provide all of the answers. Organizations and their personnel provide a valuable resource for information that is not easily found elsewhere. Referral services, government agencies, professional organizations, trade associations, universities, private industry, and other special interest groups have access to a wealth of knowledge.

SUMMARY
PART II:
ORGANIZATIONS PROVIDING FOOD AND NUTRITION INFORMATION SERVICES

Public	*Partial Public Support*	*Private*
National Referral Center *Food and Agriculture Organization* *U.S. Congress* *U.S. Government Agencies* *Public Health Agencies*	*Colleges and Universities* *Foundations* *Research Institutes*	*Professional Associations* *Health Related Organizations* *Trade Associations* *Food Industry Manufacturers* *Special Interest Groups*

National Referral Center:

A good starting point for identifying organizations in food and nutrition is the Library of Congress' National Referral Center.[6] This free referral service uses a subject-indexed, computer file of 13,000 organizations to identify pertinent resources. Descriptions of each information resource includes its special fields of interest and the types of information service it is willing to provide. This information is generally provided to the requestor in the form of a computer printout. Requests for referral services can be made by letter, telephone, or in person.

Food and Agriculture Organization of the United Nations (FAO):

The FAO is concerned with agricultural development, world food production, and nutrition issues. The FAO publishes periodicals, annuals, monographs, meeting reports, manuals, glossaries, bibliographies, surveys, directories, vocabularies, and catalogs. The North American Liaison Office in Washington, D.C. answers nontechnical inquiries. Specific questions may be referred to the FAO headquarters in Rome.

The FAO also sponsors a world-wide agricultural information system called AGRIS (International Information System for the Agricultural Sciences and Technology). The AGRIS Coordinating Center receives, organizes, and processes the national bibliographic citations prepared by the participating centers and makes the integrated total data base available to them in two formats: printed bibliography and magnetic tape. Technical Information Systems (the National Agricultural Library) contributes the U.S. citations to the AGRIS data base.

U.S. Government:

U.S. Congress

The Senate and House Committees on Agriculture are responsible for laws dealing with general farm, food, and nutrition policy. Transcripts of hearings, legislative calendars, and committee prints can be obtained from the appropriate Committee office. In addition, the Committees answer inquiries from the public on agricultural topics. Often citizen inquiries are redirected to the appropriate federal agency for response.

In June 1978, the U.S. Senate Committee on Appropriations requested the General Accounting Office to design and compile a prototype inventory of federal food, agriculture, and nutrition programs. The prototype inventory was completed in March 1979 with 359 programs identified.[7]

U.S. Department of Agriculture (USDA)

The USDA takes the lead in program emphasis on food and human nutrition. Scientists and educators would be especially interested in the work that is undertaken by the Science and Education Administration (SEA) of USDA. Included in SEA are the food and nutrition research, extension, and technical information activities of USDA. Agricultural Research and Cooperative Research are responsible for on-going research funded by USDA both at land-grant universities and colleges as well as within the USDA research centers. In addition, the Human Nutrition Center is responsible for the human nutrition research and the coordination of nutrition information and nutrition education activities of USDA.

Technical Information Systems, which includes the National Agricultural Library, maintains data on food and nutrition and is responsible for the AGRICOLA and CRIS data bases, Current Awareness Literature Service, and the Food and Nutrition Information Center (FNIC).[8] FNIC not only contributes to the AGRICOLA data base but also provides document delivery and reference services to food and nutrition professionals throughout the nation.

Other USDA agencies that might be of interest to food and nutrition professionals include the Food and Nutrition Service, the Food Safety and Quality Service, the Office of Governmental and Public Affairs, the Economics, Statistics, and Cooperatives Service, the Agricultural Marketing Service, and the Animal and Plant Health Inspection Service.[9]

U.S. Department of Health, Education, and Welfare (DHEW)

The Food and Drug Administration, Bureau of Foods, conducts and funds research and develops regulations on the composition, quality, and safety of foods, including fish, dairy products, fresh fruit and vegetables, processed food, and food additives. In addition, they develop food labeling and packaging standards.

The National Institutes of Health support and conduct biomedical research into the causes and prevention of diseases. A portion of their research deals with human nutrition and its relation to disease.

The National Library of Medicine provides medical library services to health professionals and to libraries in medical schools, hospitals, and research institutions.

Other DHEW agencies related to food and nutrition include the National Center for Toxicological Research (FDA), the National Center for Health Statistics, the Office of Maternal and Child Health, and the Center for Disease Control.[10]

Additional Government Information Resources

Other government or government-related agencies that sponsor programs or research in food and nutrition include the U.S. Agency for International Development (Department of State), Community Services Administration, U.S. Department of Defense, the Federal Trade Commission, the Food and Nutrition Board of the National Academy of Sciences, and the National Science Foundation.

Colleges and Universities:

Food scientists and nutritionists in universities and colleges may be located in several departments. The names of these departments vary from one school to another but generally they would be in the agriculture and home economics curriculum areas.

Land-grant institutions house the State offices of the Cooperative Extension Service. The Extension Service provides a network of information dissemination through the Cooperative Extension Service at the State land-grant college and at the local levels. The latest research findings are relayed to the practitioner by Cooperative Extension educators using the entire range of information methods: personal contact; group meetings; mass media; shopping mall programs; correspondence courses; computer-assisted programs; exhibits, and newsletters. For further information on the services of the Cooperative Extension Service, contact your local county Extension office.

A publication entitled, "Professional Workers in State Agricultural Experiment Stations and Other Cooperating State Institutions," Agriculture Handbook No. 305, is regularly updated and contains the names of faculty and personnel at land-grant colleges (colleges of agriculture and home economics), agricultural experiment stations, and Cooperative Extension.[11]

Foundations and Research Institutes:

Foundations and research institutes such as the National Science Foundation, the Nutrition Foundation, and the American Institute of Baking sponsor research and often issue educational publications. These organizations answer inquiries related to specific aspects of food and nutrition in their area of expertise.

Professional Organizations:

Food and nutrition professional societies are generally composed of memberships broad enough to take into account different points of view. Most members are currently working in the field and presumably need to keep abreast of the latest information.

Some food and nutrition related professional societies such as the Institute of Food Technologists, the American Association of Cereal Chemists, the Nutrition Today Society, and the American School Food Service Association are staffed to provide answers or make referrals to inquiries that fall within their area of expertise.

In some cases, several professional societies have banded together to form a consortium. An example of this is the National Nutrition Consortium (NNC), which is currently comprised of the American Dietetic Association, the American Institute of Nutrition, the American Society for Clinical Nutrition, the Institute of Food Technologists, the Society for Nutrition Education, the American Academy of Pediatrics, the American College of Nutrition, the American Home Economics Association, the American Society for Parenteral and Enteral Nutrition, and the Food and Nutrition Board of the National Academy of Sciences. The NNC seeks to fill the gaps in nutrition education, food and nutrition governmental policies, and public awareness of food and health.

Public Health Agencies and Other Health Related Groups:

Nutritional services are a part of every State health department. Many county and city health departments have nutritionists on their staff who provide nutrition information to the public and, in some cases, conduct active nutrition education programs. Programs for the elderly as well as pregnant women, infants, and children utilize the services of nutritionists at the community level.

Hospitals and Health Maintenance Organizations (HMO's) have nutritionists and/or dietitians on their staffs who are available for consultation.

Other health related groups such as the American Heart Association, the American Diabetes Association, and the National Foundation/March of Dimes provide nutrition information and produce nutrition education materials. These organizations have local chapters which might be active in your community.

Trade Associations, Food Industry Manufacturers, and Other Special Interest Groups:

Information on food and nutrition can also be obtained from trade associations such as the United Fresh Fruit and Vegetable Association, the National Live Stock and Meat Board, and the National Dairy Council. Besides answering specific questions in their area of interest, many trade associations issue publications including educational materials which are available to the public.

Food industry manufacturers such as General Mills, Inc., Sunkist Growers, Inc., and Kraft, Inc., produce print and audiovisual materials which may or may not promote their company's products. As a result of much public criticism

Robyn Frank (right) showing some of the audio-visual resources to Dr. Dorothy Van Zandt, Food and Nutrition Specialist in the Cooperative Extension Service at the University of Maryland (Courtesy, U.S. Department of Agriculture).

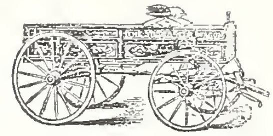
concerning the promotion of company products in their nutrition publications, many food industry manufacturers have responded by redirecting their messages to include sound nutritional information. Food companies also have very comprehensive libraries which may or may not be open to the public.

Other special interest groups, such as the Center for Science in the Public Interest, play the advocate's role in food and nutrition education. Other such groups include the Food Research and Action Center, the American Vegetarian Society, and the Consumer Federation of America. Publications issued by these groups reflect a specific point of view.

SUMMARY

This paper has highlighted some of the major information

resources available in the field of food and nutrition. By utilizing computerized data bases plus organizational and human resources, persons can identify pertinent information that can be helpful in formulating policy, making decisions, and improving health.



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2. U.S. Department of Agriculture and U.S. Department of Health, Education, and Welfare, "Nutrition and Your Health: Dietary Guidelines for Americans," (February 1980).

3. Contact: Consumer and Food Economics Institute, SEA/USDA, Room 309, Federal Building, Hyattsville, Maryland 20782.

4. Contact: Lockheed Information Systems, Code 5020/201, 3251 Hanover Street, Palo Alto, California 94304; SDC Search Service, 2500 Colorado Avenue, Santa Monica, California 90406; BRS, Inc., 702 Corporation Park, Scotia, New York 12302.

5. Contact: Current Awareness Literature Service, SEA/USDA, National Agricultural Library, Beltsville, Maryland 20705.

6. Contact: Library of Congress, National Referral Center, Washington, D.C. 20540.

7. Available from: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

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(Above illustration is "The Original Buckeye Mower and Reaper" in *American Agriculturist*, April, 1863; illustration at top of page is "Farm Wagon, Full Size" in *American Agriculturist*, October, 1879).

REFERENCES FOR THE HISTORY OF HUMAN NUTRITION IN AMERICA, 1600 TO THE PRESENT: A SELECTED BIBLIOGRAPHY

COMPILED BY

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"Whatever paths one prefers to follow he is constantly learning about the food habits of men." (Clive M. McCay)

or

"Those who still do not believe there is a God in heaven have not heard the news that hot and sour soup and mushu pork may prevent heart disease." (Calvin Trillin)

Compiling this bibliography was a humbling experience. Time was short and the literature was both vast and often inaccessible. Above all, nutrition is such a complex combination of factors--scientific, technological, social, and cultural--and each of these factors has its own fascinating history. This bibliography is an attempt to focus upon the historical development of food and nutrition in America.

Nutrition as a science basically has been considered to be a twentieth century accomplishment. Many of the citations included in this bibliography deal with the histories of scientific investigations carried out in the United States in the recent past. The foundations, though, for much of this work lay in earlier observations and numerous references elaborate these relationships. The use of food, however, is much more than nutritional science. The study of how societies and individuals decide what to eat is a subject involving many disciplines. Researchers in history, nutrition, food science, sociology, and anthropology should be assisted by these references,

First, the author would like to provide some definitions and explanations. Histories for the purposes of this compilation are descriptive narrative material about the past or reviews of technical material usually covering a five year period or longer. This rule is broken, however, for references covering unique kinds of relevant historical events not likely to be encountered elsewhere. Food is considered as that which is nutritious and also that which pleases; therefore, some material on alcoholic beverages and mineral waters is included. Food fadism and quackery make up a large body of the literature and, since their impact on American eating habits has been significant, some references have been included. Nutrition, finally, is defined as the process by which a plant or animal absorbs and uses food.

References in this bibliography include books, texts on nutrition containing chapters on history, journal articles, biographies and autobiographies, histories of relevant organizations, essays, and dissertations. All pertain to the history of nutrition in America or to the history of American food habits, the consequences of these habits, and the role of government and industry in the protection and enhancement of the diet. Most citations are secondary sources; however, some primary works are noted, particularly early writings on diet and nutrition published in America. Most of the literature cited was found in the collections of the National Library of Medicine, the National Agricultural Library, and the Library of Congress. Some items could not be located for purposes of annotation but these are included for interest. These particular items are designated by an asterisk (*).

Now, some attention to what has been left out. References on the nutrition and food habits of Native Americans would be a work in itself and are not included, thus excluding much early work. There are general historical references to government food policy but these have not been examined extensively. Also, no specific references to plant or animal nutrition are included except when critical to other works on the evolution of human nutritional science. The compiler has not attempted to list all the classic experiments in American nutrition but has provided many secondary sources citing them. Foreign studies, though numerous and significant, generally are not included except those that are relevant to American subjects.

The bibliography is arranged alphabetically by author. In assition to the references, researchers in the history of nutrition may find the following indexes, information services, and publications useful:

(1) *Index Medicus* cites historical articles under a number of subject headings including nutrition, diet, food, and cookery;

(2) *Index Catalogue of the Library of The Surgeon-General's Office* is a series which provides numerous primary sources for historical material in the medical sciences;

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The author acknowledges the suggestion of this work and the early guidance given by G. Terry Sharrer of the Smithsonian Institution. Also the assistance and help provided by Alan Fusonie of the National Agricultural Library is greatly appreciated. Parts of this bibliography were submitted as a special topic in nutrition at the University of Maryland under the supervision of Mary Alice Caliendo.

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269. *Richman, I. "The History of the Tomato in America." *Proceedings of the New Jersey Historical Society* 80 (1962): 153-

270. Riddell, William Renwick. "Old Time Dietetics in Natural Magic." *Medical Journal and Record* 136 (1932): 32-34. Ancient cures by diet.

271. Rider, Agatha Ann. "Elmer Verner McCollum--A Biographical Sketch." *Journal of Nutrition* 100 (January, 1970): 3-10. Career of a notable American nutritionist.

272. *Risch, E. *Quartermaster Support of the Army. A History of the Corps 1775-1939.* Washington: Quartermaster Historian's Office, 1962.

273. Robb-Smith, A.H.T. "Doctors at Table." *Journal of the American Medical Association* 224 (April, 1973): 28-34. Illus. Physicians who have written about cookery and dietetics.

274. Roe, Daphne A. "Lucy Wells (1888--1964): A Biographical Sketch." *Journal of Nutrition* 108 (September, 1978): 1379-1383. English pioneer working in nutritional anemias.

275. Roe, Daphne A. *A Plague of Corn: The Social History of Pellagra.* Ithaca: Cornell University Press, 1973. 217 pp., illus. History of pellagra as a disease of the lowest socioeconomic groups dependent upon corn as a staple.

276. Rorabaugh, W.J. "Estimated U.S. Alcoholic Beverage Consumption, 1790-1860." *Journal of the Studies on Alcohol* 37 (March, 1976): 357-364. Amounts and kinds of alcoholic beverages used during the period; causes of fluctuations of consumption due to diet, temperance workers, and abundant grain.

277. Rose, William C. "The Sequence of Events Leading to the Establishment of the Amino Acid Needs of Man." *American Journal of Public Health* 58 (November, 1968): 2020-2027.

278. Rosen, George. "Notes on the Reception and Influence of William Beaumont's Discovery." *Bulletin of the History of Medicine* 13 (May, 1943): 631-642. Refers mainly to the effect of Beaumont's work in Europe and is a study in the transfer of medical information.

279. Rosenberg, Charles E. "Graham Lusk." *Dictionary of Scientific Biography* 8 (1973): 555-556. Noted for metabolism studies and as an author.

280. Rosenberg, H.R. "The Fiftieth Anniversary of Casimir Funk's Vitamines." *Nutrition Reviews* 20 (December, 1962): 353-355. Review of Funk's numerous contributions.

281. "Salmon, William Davis (1895-1966)--A Biographical Sketch." *Journal of Nutrition* 108 (January, 1978): 15-21. Researcher in nutritional deficiency diseases, particularly those of the South.

282. Salmonsen, Ella M. *Bibliographical Survey of Vitamins 1650-1930.* Chicago: Mark H. Wodlinger, 1932. 344 pp.

283. Sandler, Benjamin P. "Thoreau, Pulmonary Tuberculosis and Dietary Deficiency." *Chest* 63 (May, 1973): 855-856. Letter analysing Thoreau's diet at Walden as protein poor and the relation of a low protein diet to susceptibility to tuberculosis.

284. *Schlesinger, Arthur M., Sr. "A Dietary Interpretation of American History." *Massachusetts Historical Society Proceedings* 48 (1949):

285. Schneider, Howard A. "Harry Steenbock (1886-1967)--A Biographical Sketch." *Journal of Nutrition* 103 (September, 1973): 1233-1247. Renowned for experiments irradiating food by ultraviolet light to promote vitamin activity; results had enormous commercial value.

286. Schwartz, Richard W. "John Harvey Kellogg." *Dictionary of American Biography*, Suppl. Three, 1941-1945 (1973): 409-411.

287. Schwartz, Richard W. *John Harvey Kellogg, M.D.* Nashville: Southern Publishing Association, 1970. 256 pp., illus. Biography from Ph.D. dissertation. Evolution and impact of Kellogg on American dietary habits and health concepts.

288. Sebrell, William H. "Clinical Nutrition in the United States." *American Journal of Public Health* 58 (November, 1968): 2035-2042. Covers period from Goldberger's studies on pellagra through work on flour enrichment; considers future problems.

289. Seifrit, Emma. "Changes in Beliefs and Food Practices in Pregnancy." *Journal of the American Dietetic Association* (November, 1961): 455-466. 142 ref. Review of diets recommended during pregnancy by numerous authorities throughout history, relevant research, and actual practices.

290. "Selected Topics in History of Nutrition: Symposium." *Federation Proceedings* 36 (May, 1977): 1903-1918. Subjects include Vitamin E, A.F. Morgan, and the founding of the American Institute of Nutrition.

291. Shank, Robert E. and Mrak, Emil M. "A Bookshelf on Food and Nutrition." *American Journal of Public Health* 45 (April, 1955): 419-428. Contains a wide range of reference material aimed at public health professionals.

292. Shank, Robert E. "Latest Advances in Nutrition." *Journal of the American Dietetic Association* 40 (February, 1962): 97-101.

293. Sherman, Henry Clapp. "A Century of Progress in the Chemistry of Nutrition." *Scientific Monthly* 37 (November, 1933): 442-447.

294. Sherman, Henry Clapp. *The Nutritional Improvement of Life.* New York: Columbia University Press, 1950. 270 pp., biblio. History of nutrition as a concern of government, 1894--World War II.

295. Sherman, Henry Clapp and Smith, S.L. *The Vitamins.* New York: The Chemical Catalogue Company, Inc., 1922. 273 pp. Summary of knowledge of the vitamins in 1922. Ch. 1, "History of Vitamin Theory."

296. Shils, Maurice E. and Goodhart, Robert S. *The Flavonoids in Biology and Medicine: A Critical Review.* New York: National Vitamin Foundation, Inc., 1956. 101 pp., biblio. Physiology of the flavonoids.

297. Shircliffe, Arnold. "American Schools of Cookery." *Journal of the American Dietetic Association* 23 (1947): 776-777. Schools of the 1870's, describes curriculum.

298. Sigerist, Henry E. "The Early Medical History of Saratoga Springs." *Bulletin of the History of Medicine* 131 (May, 1943): 540-584. Illus. The healing waters were known to Indians and colonists and were described and analyzed in the 18th and early 19th centuries. Early and modern analyses are compared.

299. Simeons, A.T.W. *Food: Fact, Foibles and Fables: The Origins of Human Nutrition.* New York: Funk & Wagnalls, 1968. 150 pp.

300. Sipple, Horace and McNutt, Kristen W. *Sugars in Nutrition.* New York: Academic Press, 1974. Pp. 3-9, Ch. 1, "Sugar in History."

301. Skyler, Jay S., ed. "The Walter Kempner Symposium." *Archives of Internal Medicine* 133 (May, 1974): 751-807. Review of effective dietary treatment of hypertension and the influence of Kempner. Reprint of study on the "rice diet."

302. *Smallzreid, K.A. *The Everlasting Pleasure: Influences on American Kitchens, Cooks and Cookery from 1565 to the year 2000.* Appleton-Century-Crofts Co., Inc., 1956.

303. Smith, Arthur H. "William Beaumont: November 21, 1785--April 25, 1853." *Journal of Nutrition* 44 (May, 1951): 3-16. Account of the life of Beaumont and his series of experiments on digestion done on a subject, Alexis St. Martine, "a man with a hole in his stomach."

304. Smith, Charlotte E. "Influence of Standards on the Nutritional Care of the Elderly." *Journal of the American Dietetic Association* 73 (August, 1978): 115-119. Review of government standards and their effect on the nutrition of the elderly in nursing homes.

305. Smith, E. "Inquiries into the Quantity of Air Inspired Throughout the Day and Night and Under the Influence of Exercise, Food, Medicine, Temperature, Etc." *Philosophy Magazine Service* 14 (1857): 546-548.

306. Smith, Sybil L. "Newer Trends in Nutrition." *Journal of the American Dietetic Association* 10 (July, 1934): 107-122. Current concepts on nutrition in 1934.

307. Smith, William O. and Howard, R. Palmer. "On Wine and Urine." *Journal of the Oklahoma State Medical Association* 69 (November, 1976): 475-482. Illus. History of urinalysis from earliest times.

308. Stearns, Genevieve. "Early Studies of Vitamin D Requirement During Growth." *American Journal of Public Health* 58 (November, 1968): 2027-2035.

309. Still, G.F. "Infantile Scurvy: Its History." *Archives of the Diseases in Childhood* 10 (1935): 211-218.

310. Stitt, Kathleen. "Nutritive Value of Diets Today and Fifty Years Ago." *Journal of the American Dietetic Association* 36 (May, 1960): 433-440. Comparison of the consumption of nutrients of 1895-1903 and 1960. References include early dietary studies by the USDA experiment stations.

311. Stransky, Eugene. "Scurvy: With Special Consideration on Infantile Scurvy: A Historical Review." *Philippine Journal of Pediatrics* 17 (February, 1968): 46-74. 192 ref. General historic review of scurvy in adults and children with a section on childhood scurvy in the Philippines.

312. Striker, Cecil. "The Evolution of Our Table." *Annals of Medical History* 10 (1928): 429-433. Changing diet and food preparation through the ages.

313. Striker, Cecil, comp. *Famous Faces in Diabetes.* Boston: G.R. Hall &

314. *Sulzbacher, W.L. "Changing American Concepts of Microbiological Standards for Foods." *Journal of Food Quality* 1 (April, 1977): 5-13.

315. *Survey of Food and Nutrition Research in the United States, 1947.* Washington: National Research Council, 1948. 306 pp. Projects listed by subject, personnel, and organization.

316. Svensson, Jon-Erik. *Compendium of Early American Folk Remedies. Receipts & Advice.* A Berkley Windhover Book. New York: Berkley Publishing Corporation, 1977. 166 pp., illus. American folkways of food, drink, medicine, and cosmetics.

317. Swanson, Pearl. "Charles Ford Langworthy; A Biographical Sketch. (August 9, 1864 to March 3, 1932)." *Journal of Nutrition* 86. An associate of Atwater who helped define and develop nutrition investigations in the U.S. Noteworthy in the development of the home economics movement with Ellen Richards.

318. Tannahill, Rhea. *Food in History.* New York: Stein and Day, 1977. Part Six, pp. 320-386, covers food supply and nutrition, 1800 to the present.

319. Tatkon, M. Daniel. *The Great Vitamin Hoax.* New York: The Macmillan Company, 1968. 212 pp. Popular review of the history of deficiency disease, vitamin research, and government regulation of industry. How vitamins became "transformed from factors for cure to factors for profit."

320. Taylor, Clara Mae. "Grace MacLeod--A Biographical Sketch (August 6, 1878--November 16, 1962)." *Journal of Nutrition* 95 (May, 1968): 3-7. Teacher, author, and researcher in energy metabolism.

321. "Teddy Roosevelt Campaigns for Good Nutrition." *School Foodservice Journal* 30 (August, 1976): 125-129. An actor portraying Roosevelt talks with students about nutrition.

322. Terris, Milton. "Evolution of Public Health and Preventative Medicine in the United States." *American Journal of Public Health* 65 (February, 1975): 161-169. History of the American Public Health Association.

323. Thompson, R.H.S. "The Function of a Vitamin--The Legacy of This Concept to Biochemistry." *Biochemical Pharmacology* 20 (March, 1971): 513-517. Work of Rudolph

Peters and the functions of vitamins within the body. Biochemical nature of deficiency disease.

324. Tobey, James A. "The Ghost of Sylvester Graham." *Hygeia* 20 (February, 1942): 124-126. History of Graham and an evaluation of his doctrines evoked by the introduction of enriched flour in 1941.

325. Todhunter, E. Neige. "Adelia Beeuwkes 1910-1966." *Journal of the American Dietetic Association* 49 (August, 1966): 131-132. Prominent nutrition educator and author, often writing on the history of nutrition.

326. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Archibald Edward Garrod--November 25, 1857--March 28, 1936." *Journal of the American Dietetic Association* 50 (May, 1967): 436. English physician, author of "Inborn Errors of Metabolism" describing genetic deficiencies in metabolism.

327. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition--Caleb Ticknor--1805-September 19, 1840." *Journal of the American Dietetic Association* 48 (May, 1966): 440. American physician concerned with dietetics.

328. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Carl von Voit--October 31, 1831-January 31, 1908." *Journal of the American Dietetic Association* 27 (October, 1951): 837. German noted for both work in protein metabolism and for his gifted students; Rubner, Lusk, and Atwater among them.

329. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Charles Ford Langworthy--August 9, 1864-March 3, 1932." *Journal of the American Dietetic Association* 30 (August, 1954): 779. Author with Atwater of the "Bulletin 28" on the composition of foods.

330. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. David Breese Jones--October 5, 1879-August 31, 1954." *Journal of the American Dietetic Association* 43 (September, 1963): Investigator on proteins and vitamins.

331. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Earle Willard McHenry--January 25, 1899-December 20, 1961." *Journal of the American Dietetic Association* 45 (November, 1964): 480.

332. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Edward Smith--1818(?)-November 6, 1875." *Journal of the American Dietetic Association* 39 (1961): 475. English physician studying the diet of various groups elaborated the importance of "the protective foods." Later recorded information to determine the quality of "general healthfulness" of the U.S. from New Orleans to Texas.

333. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Elmer Martin Nelson--July 5, 1892-December 24, 1958." *Journal of the American Dietetic Association* 43 (1963): 500. Authority on vitamins associated with FDA.

334. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition: Grace MacLeod--August 6, 1878-November 16, 1967." *Journal of the American Dietetic Association* 44 (June, 1964): 495. Professor of nutrition and head of the department, Teachers College, Columbia University. Research mainly in energy metabolism.

335. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Harold Russell Sandstead--December 17, 1904-November 1, 1955." *Journal of the American Dietetic Association* 46 (March, 1965): 182. Public health nutritionist; developed methodology for nutrition surveys and procedures to relieve malnutrition.

336. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Hazel Marie Hauck--July 15, 1900-April 23, 1964." *Journal of the American Dietetic Association* 47 (September, 1965): 191. Nutritionist and educator at Cornell; participated in studies in developing countries.

337. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. James Henry Salisbury--October 13, 1823-August 23, 1905." *Journal of the American Dietetic Association* 36 (May, 1960): 461. Noted for first chemical analysis of American food-corn. Recommended therapeutic qualities of ground beef--"Salisbury Steak."

338. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. John Stanton Gould--1811-August 8, 1874." *Journal of the American Dietetic Association* 44 (April, 1964): 310. Professor of Agriculture at Cornell; also involved in prison reform; studied management of public institutions including dietary evaluations of institutionalized populations.

339. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Justus von Liebig--May 12, 1803-April 18, 1875." *Journal of the American Dietetic Association* 28 (May, 1952): 442. Helped define research in chemistry; trained many future leaders, especially in nutrition.

340. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Lafayette Benedict Mendel--February 5, 1872-December 9, 1935." *Journal of the American Dietetic Association* 30 (February, 1954): 116. Biochemist and influential teacher at Yale; known for studies of essential amino acids, Vitamin A and B-complex.

341. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Lyon Playfair--May 21, 1818-May 29, 1898." *Journal of the American Dietetic Association* 42 (May, 1963): 393. Conducted dietary studies in England to relate work on food needs; active in public health work.

342. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Max Rubner--June 2, 1854-April 27, 1932." *Journal of the American Dietetic Association* 27 (June, 1951): 479. Student of Voit, colleague of Atwater and Lusk. Known for the standard caloric values for proteins, fats, and carbohydrates used to calculate and analyze diets.

343. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Norman Hayhurst Jolliffe--August 18, 1901-August 1, 1961." *Journal of the American Dietetic Association* 45 (September, 1964): 245. Public health nutritionist; expert on international dietary surveys; scientific and popular writer.

344. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Russell Henry Chittenden--February 18, 1856-December 26, 1943." *Journal of the American Dietetic Association* 27 (February, 1951): 105. Biochemist; researcher on enzymes and proteins.

345. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Sarah Tyson Rorer--October 18, 1849-December 27, 1937." *Journal of the American Dietetic Association* 42 (January, 1963): 75. "First American dietician and a pioneer in applied nutrition."

346. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Stanley Rossiter Benedict--March 17, 1884-December 21, 1936." *Journal of the American Dietetic Association* 31 (March, 1955): 249. Distinguished biochemist; known for "Benedict's Solution" and the test for glucose in urine.

347. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Sylvester Graham--July 5, 1794-September 11, 1851." *Journal of the American Dietetic Association* 31 (July, 1955): 31, 711. Popularizer of some sound and many eccentric practices who spread much interest in diet and hygiene.

348. Todhunter, E. Neige. "Biographical Notes from the History of Nutrition. Walter Charles Russell--October 1, 1892-March 10, 1954." *Journal of the American Dietetic Association* 49 (July, 1966) 45. Researcher on vitamins; Professor at Rutgers.

349. Todhunter, E. Neige. "Chronology of Some Events

in the Development and Application of the Science of Nutrition." *Nutrition Reviews* 34 (December, 1976): 353-365. Author desires "to place the development of nutrition in perspective of time, world events and overall progress in science." Chronological listing of many events in nutrition from earliest history to 1971.

350. Todhunter, E. Neige. "Contributors to Man's Health and Nutrition--Four Centennials." *Journal of the American Dietetic Association* 25 (December, 1949): 1010-1011. 1949 was the centennial and bicentennial of the birth of four figures in nutrition--Blane, Takaki, Jenner, and Osler.

351. Todhunter, E. Neige. "Development of Knowledge in Nutrition. 1. Animal Experiments. 2. Human Experiments." *Journal of the American Dietetic Association* 41 (October, 1962): 328-340. "The men, methods and the ideas" in the history of nutrition; thoughts on how the study of history allows insights into future work.

352. Todhunter, E. Neige. "The Evolution of Nutrition Concepts--Perspectives and New Horizons." *Journal of the American Dietetic Association* 46 (February, 1965): 120-128. Illus. Development of nutrition into a science. Describes some early sources which led to major developments in the 20th century.

353. Todhunter, E. Neige. "Food Composition Tables in the U.S.A. A History of 'Bulletin 28.'" *Journal of the American Dietetic Association* 37 (September, 1960): 209-214. "Bulletin 28" was the first organized tabular data specifically on the composition of food in the American diet. Its wide use and numerous successors make it a landmark in American nutrition.

354. Todhunter, E. Neige. "Iron, Blood and Nutrition." *Journal of the American Dietetic Association* 61 (August, 1972): 121-125. History of iron and the investigations leading to some understanding of its place in human nutrition.

355. Todhunter, E. Neige. "Nutrition and the Food Supply During the Revolutionary Period." *Food Technology* 30 (July, 1976): 32-34. Factors determining food available and the nutritional status of Americans in 1776. Brief review of the history of nutrition in the U.S.

356. Todhunter, E. Neige. "Russell Henry Chittenden." *Alabama Journal of Medical Sciences* 2 (July, 1965): 337-341. Founder of biochemistry in the U.S.

357. Todhunter, E. Neige. "Russell M. Wilder--November 24, 1885-December 16, 1959." *Journal of the American Dietetic Association* 40 (June, 1962): 539. Researcher in sugar and glucose metabolism, treatment of diabetes, and other metabolic problems.

358. Todhunter, E. Neige. "Some Aspects of the History of Dietetics." *World Review of Nutrition and Dietetics* 5 (1965): 32-78. Reprinted 18 (1973): 1-46. Covers range of topics; author wishes to distinguish between nutrition and dietetics.

359. Todhunter, E. Neige. "Some Classics of Nutrition and Dietetics." *Journal of the American Dietetic Association* 44 (February, 1964): 100-108. Illus. Review of the major writings, in English, on nutrition; reasons why the author feels they qualify as "classics." Listing covers 1753-1950 and one from 1961.

360. Todhunter, E. Neige. "The Story of Nutrition." *Yearbook of Agriculture*. Washington: U.S. Department of Agriculture, 1959. Pp. 7-22.

361. Todhunter, E. Neige. "Women in Nutrition." *Professional Nutritionist* 9 (Fall, 1977): 12-14. Early pioneers in home economics and nutrition.

362. Tremolieres, J. "A History of Dietetics." *Progress of Food and Nutrition Sciences* 1 (1975)L 65-114. Monumental historical world view of the interrelationships of man, food, culture, and disease. A translation; few English citations in bibliography.

363. Trowell, Hugh. "The Development of the Concept of Dietary Fiber in Human Nutrition." *American Journal of Clinical Nutrition* 31, Suppl. 10 (October, 1978): 3-11. 60 ref. Review of the importance of fiber in the human diet and the relationship of fiber to diseases common in the West. Part of a Symposium on the "Role of Dietary Fiber in Health."

364. Trulson, Martha F. "The American Diet--Past and Present." *American Journal of Clinical Nutrition* 7 (January/February, 1959): 91-97. Compares consumption data from the USDA for a period of about 50 years to establish trends in food patterns.

365. *Twyman, R.W. "The Clay Eater: A New Look at an Old Southern Enigma." *Journal of Southern History* 37 (1971): 439-448.

366. U.S. Consumer and Marketing Service. *National School Lunch Program*. Washington: Government Printing Office, 1968. Includes a history of the lunch program.

367. *U.S. Department of Agriculture. Office of Experiment Stations. Bulletin 71. *Dietary Studies of Negroes in Eastern Virginia in 1897 and 1891*. Washington: U.S.D.A., 1899. 45 pp.

368. *U.S. Department of Agriculture. Science and Education Administration. *The Expanded Food and Nutrition Education Program: Historical and Statistical Profile*. Washington: U.S.D.A., 1979. 131 pp., biblio.

369. U.S. Food and Nutrition Service. *Chronological Legislative History of Child Nutrition Programs*. Washington: Food and Nutrition Service, 1974. 73 pp.

370. U.S. Food and Nutrition Service. *National School Lunch Program: Background and Development*. Washington: U.S. Government Printing Office, 1971. 30 pp. History of the program to present.

271. Van Slyke, Calla. "Some Pictures of Food Consumption in the United States. Part I." *Journal of the American Dietetic Association* 21 (September/October, 1945): 508-512. Covers period 1630 to 1860. Part II, 21 (December, 1945): 690-695. Covers period 1860 to 1941.

372. Vickery, H.B. "Thomas Burr Osborne." *Dictionary of Scientific Biography* 10 (1974): 241-244. Associate of Lafayette Mendel working on vitamins and proteins.

373. Weber, G.M. and Alsberg, C.L. *The American Vegetable-Shortening Industry: Its Origin and Development*. Fats and Oils Studies No. 5, Stanford University Food Research Institute: Stanford University, 1934.

374. Weigley, Emma Seifrit. "Food in the Days of the Declaration of Independence." *Journal of the American Dietetic Association* 45 (July, 1964): 35-40. Bibliography on food habits of the period.

375. Weigley, Emma Seifrit. "Mary Davies Swartz Rose." *Dictionary of American Biography*, Suppl. 3, 1941-1945 (1973): 670-672.

376. Weigley, Emma Seifrit. *Sarah Tyson Rorer, The Nation's Instructress in Dietetics and Cookery*. Philadelphia: American Philosophical Society, 1977. 196 pp. Biography of early home economist.

377. White, Hilda S. "Man and His Diet." *Archives of Environmental Health* 20 (January, 1970): 84-87. Interrelationship of environment and diet.

378. White, J.E. "Cursory Observations of the Soil, Climate and Diseases of Georgia." *Medical Repository* 10 (1806-1807): 121.

379. *Whitehead, Floy E. *Nutrition Education Research - Report of Phase I*. Washington: Agency for International Development, 1970. 127 pp. Literature review including summaries of results on nutrition education reports 1900-1970.

380. Wickes, Ian G. "History of Infant Feeding." *Archives of Diseases in Children* 28 "Part I. Primitive Peoples: Ancient Works: Renaissance Writers," (April, 1953): 151-158; "Part II. Seventeenth and Eighteenth Centuries," (June, 1953): 232-240; "Part III. Eighteenthe and Nineteenth Century Writers," (August, 1953): 332-340, "Part IV. Nineteenth Century Continued," (October, 1953): 416-422; "Part V. Nineteenth Century Concluded and Twentieth Century," (December, 1953): 495-502. Mainly British, comprehensive.

381. Wilder, Russell M. "Brief History of the Enrichment of Flour and Bread." *Journal of the American Medical Association* 162 (December, 1956): 1539-1541.

382. Wilder, Russell M. "Enriched Flour and Enriched Bread: How It Started." *Nutrition--The Armor of Robust Health.* Washington: U.S. Office of Defense Health and Welfare Services, Nutrition Advisory Committee, 1941. Reprint of a paper read at a conference of bakers and millers to prepare them for the introduction of enriched bread and flour.

383. Wilder, Russell M. and Williams, Robert R. *Enrichment of Flour and Bread: A History of the Movement.* Washington: National Research Council, 1944. 130 pp., biblio.

384. Wilder, Russell M. "The Significance of Diet in Treatment." *Journal of the American Medical Association* 97 (August, 1931): 435-436. What physicians should know about nutrition.

385. Wiley, Harvey W. *An Autobiography.* Indianapolis: The Bobbs-Merrill Company, 1930. 339 pp., illus. Crusader in the fight for pure food.

386. Wiley, Harvey W. *Foods and Their Adulteration: Origin, Manufacture and Composition of Food Products; Description of Common Adulterations; Food Standards and National Food Laws and Regulation.* Philadelphia: P. Bladiston's Son and Company, 1907. 625 pp., illus. Information for the public to encourage honest manufacturing practices.

387. Wiley, Harvey W. *The History of a Crime Against the Food Law.* Washington: The Author, 1929. 413 pp., illus. A description of the campaign by many prominent figures, political and scientific, to subvert the intent of the Pure Food and Drugs Act.

388. Williams Robert R. "Progress in Cereal Enrichment." *Journal of the American Dietetic Association* 27 (April, 1951): 293-297. History of enrichment in U.S. and abroad.

389. Williams Robert Runnell. *Toward the Conquest of Beriberi.* Cambridge: Harvard University Press, 1961. 338 pp., biblio., illus. Major events and investigators associated with research on thiamine. Epidemiology of beriberi and the use of government nutrition programs in public health work.

390. Williams, Robert Runnell. *Williams--Waterman Fund for the Combat of Dietary Diseases: A History of the Period 1935 Through 1955.* New York: Research Corporation, 1956. 120 pp., illus. Research on isolating and synthesizing of thiamine and the use of the royalties resulting from the patents. Candid story of enrichment of flour, domestic and foreign.

391. Wilson, M.T. "Isabel Bevier." *Dictionary of American Biography*, Suppl. 3, 1941-1945 (1973): 67-69. Early home economist.

392. Wood, Alice L. "The History of Artificial Feeding of Infants." *Journal of the American Dietetic Association* 31 (May, 1955): 474-482. 96 ref. From earliest records through contemporary practices.

393. Wood, Bertha M. *Foods of the Foreign Born in Relation to Health.* Boston: Whitcomb & Barrows, 1922. 98 pp. Early views on the need to include cultural considerations when trying to change dietary habits or administer therapeutic regimens. Includes ethnic recipes suitable for special diets.

394. *Woods, R.L. *Government Guides to Health and Nutrition Compiled With Commentaries.* New York: Pyramid Books, 1975.

395. Youmans, John B. "The Changing Face of Nutritional Disease in America." *Journal of the American Medical Association* 189 (August, 1964): 672-676. Past and present nutrition problems.

396. Young, James Harvey. "Botulism and the Ripe Olive Scare of 1919-1920." *Bulletin of the History of Medicine* 50 (Fall, 1976): 372-391. Presents a history of botulism poisoning; outbreak in title came from commercially processed ripe olives, which led to the almost collapse of the then new industry. This, in turn, stimulated new research in food technology and the enforcement of food and drug legislation.

397. Young, James Harvey. "The Science and Morals of Metabolism: Catsup and Benzoate of Soda." *Journal of the History of Medicine and Allied Sciences* 23 (January, 1968): 86-104. Evaluation of the chemical preservative as used in processed food in the early 20th century. Work of Harvey W. Wiley and the role of government in protecting public health.

398. Young, John R. *An Experimental Inquiry Into the Principles of Nutrition and the Digestive Process.* Philadelphia: Eakin & Mecum, Printers, 1803. Facsimile Reprint. Urbana: University of Illinois Press, 1959. 48 pp. One of the first nutrition experiments in the United States.

399. Yudkin, John. "Evolution, History and Nutrition: Their Bearing on Oral Disease and Other Diseases of Civilization." *Dental Practitioner* 16 (October, 1965): 60-64. Associates the increase in dietary intake of refined sugar with a number of diseases of civilization.

Arcadio, California (Photo, Charles O'Rear; Courtesy, The Face of Rural America: The 1976 Yearbook of Agriculture*).*

NEW  ACQUISITIONS

This section provides a selective listing of recent NAL acquisitions. The NAL call number is provided with the citation (if available).

Persons having questions or suggestions concerning this listing should contact Beth Whiting, Cataloging Section, Room 110, NAL Building, Beltsville, MD 20705.

AWWA Water Quality Technology Conference. 6th Annual. Louisville, Kentucky, 1978. *New laboratory tools for quality control in water treatment and distribution.* Denver: American Water Works Association, 1979.

Aebi, Ormond. *Mastering the art of beekeeping.* Santa Cruz, Calif.: Unity Press, 1980. (SF523.A293)

Annotated bibliography for aquatic resource management of the Upper Colorado River ecosystem. Richard S. Wydoski . . . et al. Washington, D.C.: Department of the Interior, Fish and Wildlife Service, 1980.

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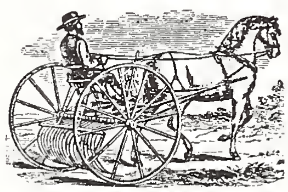
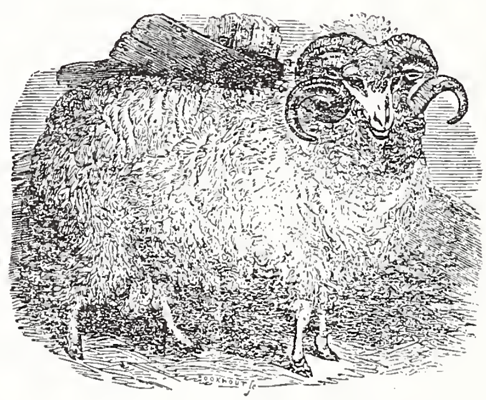
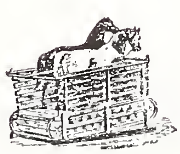
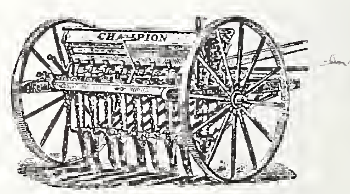




MERINO RAM.



(Center, "Merino Ram" in L.A. Morrell's *American Shepherd . . .*, 1846, Courtesy, Rare Book Collection, National Agricultural Library; top left, "The Gale Horse Hay-Rake" and, top right, "The Monitor Corn Sheller" both in *American Agriculturist*, October, 1879; bottom left, "Union Railway Horse Power, Threshers and Separators" and, bottom right, "The Champion Grain Drill" both in *American Agriculturist*, August, 1880).



BOOK REVIEWS

Persons interested in reviewing books, having books reviewed, or simply having questions about the reviews should address their correspondence to Tom Fulton, Journal of NAL Associates, *Room 150, GHI Building, 500 12th Street, S.W., Washington, D.C. 20250.*

Campbell, Keith O. *Food for the Future: How Agriculture Can Meet the Challenge.* (Lincoln and London: University of Nebraska Press, 1979, 178 pp., index, $12.50).

If a reader is looking for a positive approach to counter the gloomy prognoses for the future world food supply, this book does precisely that. Campbell asserts emphatically that science and technology applied to agriculture will increase world food production sufficiently to feed the additional two billion people to be born by the year 2000. The development of agricultural technology needs public support of agricultural scientists, followed by rational government policies that insure this food supply reaches people throughout the world.

The book has twelve chapters that roughly cover three themes. Campbell's first theme describes the current world food situation showing how developing countries have kept pace with population growth. He adds, however, that the world will find it difficult to maintain a high rate of gain in output in production when gains are jeopardized by post-harvest losses and by weather conditions that are beyond human control. Resources such as land, water, fertilizer, and fossil fuels for tractors, crop drying, and transport with limited scope for substituting other forms of energy.

The second major theme of the book describes the critical role of agricultural research, the constraints on disseminating new discoveries, and the institutional problems of research. In the third and last part, the author, in a pithy critical style, refutes simplistic soomsday arguments by showing which political, economic, infrastructural, and institutional constraints on the world's food supply need to be overcome.

The great value in this book is its brief effective summary of key food supply constraints. He states:

> Credit and tenure reforms, proper management of irrigation water, the institution of regional research centers to insure that new crop varieties are suitable locally, measures to control the movement of plague locusts, and action to secure the continuity of regular supplies of inputs can effectively reduce some of the farmers anxieties.

Most nations want and have to supply most of their own food through local production. Relying on imports of food become difficult because there is a limited supply of international food stocks at times, as well as problems of scarce foreign exchange and logistical problems in transporting bulky food stuffs. Campbell, therefore, concludes that countries must look internally at their problems and provide policies that in reality give local farmers incentives to produce more food. Campbell then lists examples of policies publicized to increase farmers' incomes that have the opposite effect. Some of these include: strong-arm land reforms; cost-price squeezes; low-interest rates on rural loans that dry up lines of credit; underpriced irrigation water; taxes on exports that remain unadjusted to world prices; overvaluing currencies making capital goods cheaper, and many more. Besides these lack of incentives to farmers, farmers must further contend with politicians' urban orientation, with consumption subsidies, and with industrial policies that use investments from which agriculture could benefit.

International trade and aid bring false hopes for food supplies. Trade provides a very small proportion of the world food supply--about one-tenth. Simulations show that the removal of trade barriers would not increase this supply. To parley these difficulties, the third world chastises developed nations' protectionism through GATT, UNCTAD, NIEO, and international commodity agreements, and points out that the developing world's hope is to stabilize world prices at high levels. Campbell's pessimism comes through in discussions about these kinds of negotiations and aid but he lays the blame squarely on the internal workings of the developing countries calling many of these governments "the major villains" of the low production of foodstuffs.

With such pithy, critical, and perceptive comments, the reader finds Campbell does not deal well with the solutions to all of these problems. It would have been a greater contribution if he had given thought as to how the fluctuations in world commodity prices could be eased and how there could be successful emergency food stocks given all the problems with the present negotiations.

Conservationists, solar power enthusiasts, and appropriate technology advocates also receive some well-aimed but harsh blows. While extremists exist in each of these movements, it would be hasty to take their position as representative. Valid long-term questions remain on the ramifications of some of these technologies but Campbell casts them aside as irrelevant. The reader may want to skim the passages filled with tirades.

The book ends leaving the reader puzzling over income distribution and food distribution problems. Both are interrelated and crucial to future world food supplies. Yet they are merely mentioned in the last paragraphs, not discussed. This lack of discussion is probably the greatest flaw in this otherwise interesting book on constraints facing future world food needs.

Reviewed by Donna Vogt, Trade Policy Branch, International Economics Division, Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture.

Gabel, Medard. *Ho-Ping: Food for Everyone.* (Garden City,

New York: Doubleday, Anchor Books, 1979, 272 pp., appendix, bibliography, charts, illustrations, maps, $9.95 pap.).

Ho-Ping: Food for Everyone is a unique publication derived from numerous World Game Workshops sponsored by R. Buckminster Fuller and was researched by Earth Metabolic Design, an educational planning organization. It attempts to demonstrate that there is adequate food for everyone on earth to have a nutritionally sound diet and food for life should be a birthright. Also, it attempts to destroy fratricidal complacency, the lifeboat and triage ethics, the contention that famines are inevitable, and the belief that hunger must always exist as long as there are the poor. The book analyzes and proposes solutions to the huge food surplus problems in a number of developed naions, unnecessary agricultural workers in increasingly mechanized agricultural systems, and energy requirements for food production--while stressing world food interdependence and integration. Global food problems, according to the author, must be viewed globally. Although not a "doomsaying" in the least, this book readily acknowledges the precarious position of our present global food system, the potential alimentary ramifications of a global climatic change, and the possible shortfalls in world grain production anticipated in the early 1980's. Strategies for insuring human survival and eliminating the omnipresent threat of famine are clearly presented.

This book, physically designed to permit the inclusion of numerous R. Buckminster Fuller's Dymaxion Sky-Ocean World Maps, is printed and bound more like a paperback atlas or lab manual with text than a hardbound book. Richly illustrated with black-and-white maps, charts, graphs, drawings, and diagrams, *Ho-Ping* is well integrated and includes a short Preface, an Introduction, four major chapters, and a lengthy three-part appendix. Major chapters discuss the following: Food, Earth and Everyone; Food Sources/Production Techniques; Food Distribution--Processing, Storage, Packaging, Preparation and Delivery, and Strategies for a Regenerative Food System. A new paradigm for viewing the world and its problems is introduced and is logical and comprehensive. This new approach, "design science," is defined by the author as a process of recognizing, defining, and solving problems, then formulating a goal and the systematic path of reaching that goal. Each chapter concludes with a section outlining "what is needed" or the preferred state, "decision-making criteria" or values that formulate a preferred state made explicit, and references. Portions or sections of chapters that include suggestions, recommendations, or approaches to be considered in solving the global food problem conclude with listings of "advantages," "disadvantages," and "what needs to be done." A major theme of this book is a plea for humans to modify current world food resource management practices from short-term productivity and profits, to optimizing long-term sustainable yields and food for everyone.

Medard Gabel has written a remarkable tome illuminating strategies to eliminate hunger and famine from the earth. Exceedingly well organized and concisely outlined, a reader is overwhelmed with detail and fact. Reading time is reduced by the mass of statistics and the volume of exciting ideas. Maps included are informative but readers not accustomed to R. Buckminster Fuller's Dymaxion Sky-Ocean Maps will have problems synthesizing spatial data to gain a global perspective. Source of map data is not always from professional scholarly sources and cartographic presentation of statistics is antiquated. Mechanical errors, editing oversights, and poor word choices detract from this fine piece of work. Concomitantly, in most "what needs to be done" listings, establishment of a global research institute to research and develop solutions to identified problems is recommended(?). Finally, the author's infatuation with the traditional Chinese approach to agricultural development and food needs is not in accord with most knowledgeable world food specialists' ideal model for increasing world food production. Agricultural differences and diversities caused by geography, climate, and weather, relative size and make-up of a population, and cultural attributes are a global strength and asset to be employed in the elimination of hunger and famine. A single model for global agricultural development that fails to take into account cultural, physical, and economic diversity would not help to eliminate hunger or famine and would not help to qualitatively improve the diets of millions. The world food problem is not a single problem. It is a complex web or constellation of problems that need to be dealt with holistically.

Reviewed by William A. Dando, Chairman, Department of Geography, The University of North Dakota, Grand Forks, North Dakota 58202.

Guither, Harold D. *The Food Lobbyists.* (Lexington, Mass.: Lexington Books, D.C. Heath and Co., 1980, xiv, 358 pp., $27.95).

The Food Lobbyists by Harold Guither is an impressive compendium on the organizations that actively solicit support for their views on food and agricultural policy. It serves as a useful introduction and reference on the actors and their respective roles in the policy arena. It is obviously the result of considerable inquiry on the part of the author.

The book is divided into nine chapters and four appendices. In the first two chapters an overview of the food and agricultural policy arena is provided. These are followed by chapters specifically devoted to: producer advocates; agribusiness interests; citizen, consumer, and specific-interest advocates, and public agency and professional organizations. A chapter is then directed at political action committees--those formal but separate organizations that represent corporations, cooperatives, and others in making campaign contributions to candidates for public office. Next, a chapter is spent on assessing the various techniques that lobbyists have available to them for expressing their positions. Finally, a look is taken at the future role of lobbyists in food and agricultural policy. The appendices contain directories of organizations and firms with legislative interests in food and agriculture, House and Senate Agriculture Committee memberships, the relationships between national citizens' and rural-oriented groups, and a listing of contributions made by food and agricultural political-action committees in 1977-78.

Although impressive in content, *The Food Lobbyists* does suffer somewhat from an unevenness in style. There is evidence of lapses into subjectivity at several points in the text. While perhaps not of major consequence, questions of credibility, nevertheless, could be aroused in the minds of some readers. Also, the chapter on "Assessing the Strategies and Tactics of Food and Agricultural Lobbyists" switches to an almost anecdotal sytle, written in "how-to" terms for would-be lobbyists. This is not in keeping with the style of the other chapters. In the several chapters that deal with the particular producer, consumer, and other lobby groups, an attempt is made to organize the presentation according to topical issues in food and agricultural policy. The intent would appear to be avoidance of a "laundry listing" approach to the organizations and their respective policy positions. Unfortunately, not enough time is spent in developing the various issue areas. Reading becomes a bit tedious as each group group's position on an issue is reviewed. Finally, the book tends to be lacking in analytical content. A much stronger presentation of the food lobbyists could have been made if a few major policy conflicts had been examined in some detail. Something along the lines of the publication *Agricultural-Food Policy Review* by Penn, Johnson, and Meekhof (ESCS-AFPR3, Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture, February, 1980) would have been extremely useful for a better understanding of the range of interests, the positions taken, and other facets of the policy process as it relates to the food lobbyists.

The Food Lobbyists, despite any shortcomings, makes a def-

inite contribution to our understanding of the policymaking process in the United States. It makes quite clear the variety of interests that find cause for expressing their views on food and agricultural policy issues. It also points up the tremendous complexity that characterizes the policy decision-making process. *The Food Lobbyists* is a valuable addition to the bookshelf of those interested in food and agricultural policy.

Reviewed by Kenneth C. Clayton, Acting Chief, Food and Agricultural Policy Branch, Economics, Statistics, and Cooperatives Service, U.S. Department of Agriculture.

Schertz, Lyle P. et al. *Another Revolution in U.S. Farming?* Economics, Statistics, and Cooperatives Service, Agricultural Economic Report No. 441 (Washington, D.C.: U.S. Department of Agriculture, 1979; Government Printing Office, 1980, xi, 445 pp., bibliography, charts, diagrams, graphs, maps).

Structure Issues of American Agriculture. U.S. Department of Agriculture, Economics, Statistics, and Cooperatives Service, Agricultural Economic Report No. 438 (Washington, D.C.: Government Printing Office, 1979, vi, 305 pp., bibliography, charts, diagrams, graphs, maps).

In some respects these two volumes are long overdue, especially for individuals who have not been keeping up with the changing structure of a dynamic agriculture. On the other hand, persons closely associated with farming and agri-business have seen and, in most cases, encouraged the changes described because they realized that if farming were to stay a viable business it had to become industrialized.

At times these two volumes seemed like nothing more than a rehash of the raw census data collected over the past four decades. At other times the story appeared as an excellent assimilation of facts woven into a concise readable story. Unfortunately, the authors did not editorialize on why some of the basic changes took place, they only described the actual process. It would appear as if they were worried that their jobs were at stake if they dared to venture an opinion. This took some of the life out of a very dramatic story about our changing agriculture.

The two volumes trace the basic causes of the changing structure of agriculture from horses to tractors to the latest four-wheel-drive tractor and the technology accompanying those power units. Chemicals, fertilizers, computers, management, genetics, finance, confinement, and automation are given their due credit for helping to complete the story of why farming has changed. Those who have had an eye on agriculture will not be startled at what is written but they will appreciate having a census compilation on file. The excellent charts, graphs, and tables add to the written text and will help to serve as a handy reference.

The major forces that have shaped contemporary American agriculture, according to the various authors, are: *inflation* which strengthened those in control; *increased exports* which often appear more harmed than helped by government or American society; availability of *capital intensive technology* which has changed the economy of scale; *non-farm employment* opportunities which have lured many farmers into better positions in the industrial society; greatly *increased supply of credit* which has helped the risk-oriented progressive farmer and also the aggressive young couples who want to start farming; *government price support programs* which from their inception out of fairness to the producer had to be based on volume and hence helped the larger farmer most, and *income tax laws* which, unfortunately, were implied to have helped the larger farmer more than the small producer.

The above forces in each case were detected early by the management-minded, risk-oriented, innovative, progressive farmers and enabled them to take another stride over the less alert producer. In successive periods, the latter found non-farm opportunities a more appealing and desirable alternative to better his socio-economic position. In each step of change, the American society benefited with the consumer always being the ultimate benefactor. That story, unfortunately, has not received its proper recognition from the consuming public. If it had there would be less concern about the changing structure of agriculture.

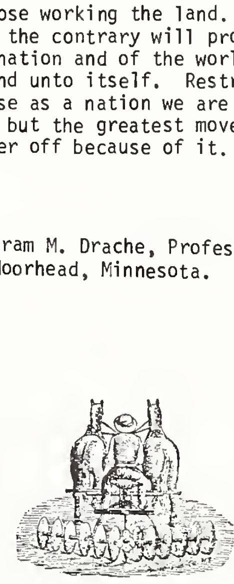
The documentation about the changes that have taken place is solid but some of the reasons given leave room for doubt. Unfortunately, those "reasons" could lead to legislative action that could do extensive harm to a now quite solidly based commercialized, industrialized, family-oriented agriculture. History gives us a grasp on the future but it does not make our future vision 20-20 because too many conditions are changing.

The tax laws that were criticized are basically equally fair to all in agriculture. Tax laws that hit at non-farm income drastically weaken the position of the young farm couples who need non-farm income to get started. Environmental legislation aimed at large commercial agri-business ventures have probably had a far more negative impact on the small farm firm. Economy of scale can be reached by a fully mechanized husband and wife or father and son operation but this changes with improved technology. The demise of the non-family farm corporation during time of stress has pointed out the fallacies of the arguments of those who predicted that they threatened the farm family.

Young farm couples have been and are now starting to farm in spite of all the propaganda to the contrary. They are a living proof that if one wants to badly enough, one can. The most glaring weakness in this two-volume study is the complete omission of any reference to what makes a successful farmer as opposed to the traits of those who are not as fortunate. To answer that, the researchers must get out on the farms and learn what really motivates people. Such research cannot be done in the rooms of the U.S.D.A. complex, nor can it realistically be done by telephone survey.

This reviewer appreciated the efforts put forth in these volumes but any legislation based solely on projections from a "look backward" would strike a serious blow to the vitality of rural America and to the economic and social progress of those working the land. More importantly, any legislation to the contrary will prove costly to the consumers of our nation and of the world, for America is no longer an island unto itself. Restructuring will slowly continue because as a nation we are still overcapitalized in agriculture but the greatest movement is past and the nation is better off because of it.

Reviewed by Hiram M. Drache, Professor of History, Concordia College, Moorhead, Minnesota.

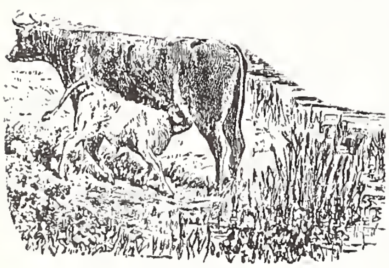


("La Dows Jointed, Pulverizing, and Smoothing Disc Harrow" in *American Agriculturist*, August, 1880).

NEWS OF NOTE

COUNTY FAIRS--YESTERDAY AND TODAY

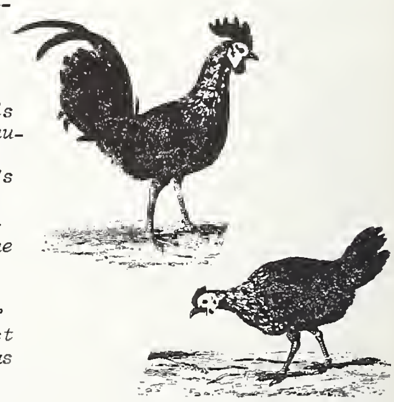
In 1855, the United States' Agricultural Society held its third agricultural exhibition in Boston, Massachusetts. From the Journal of The United States Agricultural Society, *1855, Historic and Rare Book Collection, National Agricultural Library.*



(From the frontispiece in Charles Louis Flint's *Milch Cows and Dairy Farming . . .*, new edition, 1864; Courtesy, Rare Book Collection, National Agricultural Library).

In 1807, Elkanah Watson, a gentleman farmer, displayed his Merino sheep in the village square in Pittsfield, Massachusetts. Three years later, he persuaded his neighbors to assist him in organizing a livestock show. Under Watson's leadership, the Berkshire Society was organized in 1811 and began sponsoring annual fairs. Historically, the emphasis of these fairs was significantly different from the market fairs of medieval Europe which emphasized buying and selling. Improvements in both crops and animals became the major features of the county fair movement. For the fur traders and trappers of the trans-Mississippi West (1825-1840), a similar gathering of people became known as the rendezvous. Throughout the latter half of the nineteenth century and on into the twentieth, the number of county fairs increased. These gatherings provided farmers with the opportunity of seeing in one location many improvements in farm machinery and farming practices as well as a chance to enjoy some entertainment and social life. Today, fairs still remain a popular activity at the state and local levels. In 1976, the attendance at the Texas State Fair totalled over three million individuals.

In 1981, the tradition, cultural heritage, and excitement of the county fair will be alive and thriving across this good land of ours. Make it a point to attend one and enjoy yourself--you won't be disappointed.



("Spanish Cock and Hen" in Bonington Moubray's *A Practical Treatise on Breeding, Rearing, and Fattening, All Kinds of Domestic Poultry, Pheasants, Pigeons, and Rabbits . . .*, 5th edition, 1824; Courtesy, Rare Book Collection, National Agricultural Library).

Richard A. Farley, Administrator, Technical Information Systems (seated center), along with four TIS staff members--(from left to right) Jeannette Shufford-Hall; Alan Fusonie; Shirley Surprenant, and Joseph Swab--examine some of the manuscripts, books, and other materials from the Kellogg Soil Science Library Collection. (Photo courtesy U.S. Department of Agriculture).

On October 16, 1980, the Charles E. Kellogg Soil Science Library Collection was donated to the Department of Agriculture. Soil science publications, manuscripts, maps, slides, and unpublished journals highlight the personal library of the late Dr. Charles E. Kellogg, internationally renowned soil scientist, adviser in soil science, speaker, and author of more than 170 articles as well as seven books including the popular texts entitled The Soils That Support Us, *1941, and* Agricultural Development: Soils, Food, People, Work, *1975. This special collection was donated to the National Agricultural Library by Lucile Kellogg (surviving wife) of Hyattsville, Maryland. Over the years, Dr. Kellogg had been a strong supporter of NAL and was an active member and President of the Associates of NAL, Inc.*

In accepting this collection, Dr. Richard A. Farley, Administrator for the Technical Information Systems (TIS/NAL) noted that Dr. Kellogg's library, assembled over a period of more than forty years, is one of the finest and largest of its kind in the world. Dr. Kellogg had made many visits to other countries to learn farming methods from the individual cultivators and to assist in agricultural development programs and town-and-country planning. An avid book collector, Dr. Kellogg's foreign travels provided many opportunities for him to acquire important scientific publications in his area of discipline and research interest. Having formed lasting friendships with his colleagues abroad, Dr. Kellogg continued to receive from them their papers, journals, maps, and books relating to soil science.

The Kellogg library is especially highlighted by typed and bound journals illustrated with the photos made on his trips along with inserted programs, place cards, and other ephemera constituting a record of the assistance he provided in solving soil problems on his foreign assignments including the Belgian Congo, Northern Canada, India, Australia, and New Zealand, France, England, and the Soviet Union. Perhaps second in importance to his own journals are the numerous soils publications inscribed or autographed to him that he received from colleagues around the world. Of equal or greater importance, the collection includes Dr. Kellogg's many and varied published writings; his contributions to the development of soil science have been numerous and of tremendous importance.

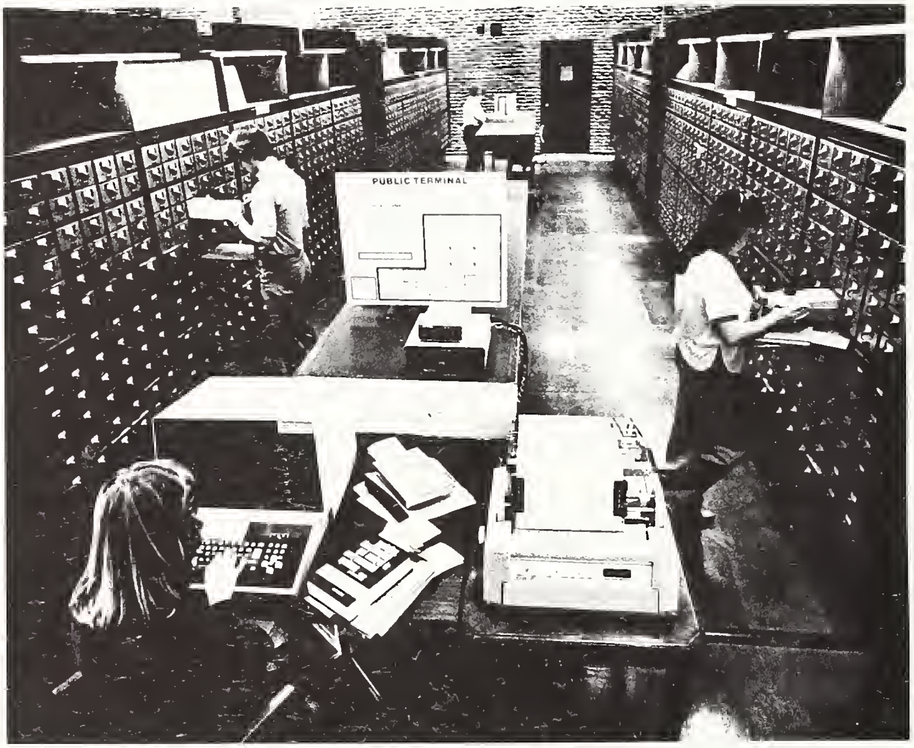
The Kellogg collection also includes rare imprint edition copies of the following works: Lucius Moderatus Columella, Of Husbandry, *1745; Sir Humphrey Davy,* Elements of Agricultural Chemistry, *1815; Henri Louis Duhamel Du Monceau,* A Practical Treatise on Husbandry, *1759; Edmund Ruffin,* An Essay on Calcareous Manures, *1832, 1853; Jethro Tull,* Horse-Hoeing Husbandry, *1829; Thomas Tusser,* Five Hundred Points of Good Husbandry, *1812; Chalres Varlo,* The Essence of Agriculture, *1786.*

Born on a farm in Ionia County, Michigan, in 1906, Dr. Kellogg went on to receive his B.S. and Ph.D. degrees from Michigan State University. During his USDA career, he served as head of the National Cooperative Soil Survey from 1934 to 1971 and was Deputy Administrator of the Soil Conservation Service, U.S. Department of Agriculture, when he retired. Under his leadership, the soil survey grew from a few scattered field parties to an organization of more than 1,400 soil scientists working in all states. He wrote the first edition of the Soil Survey Manual *issued in 1939 and subsequently adopted by soil survey organizations throughout the world. Dr. Kellogg was the recipient of many awards including the Distinguished Service Citation and Gold Medal, U.S. Department of Agriculture (1950), the Distinguished Service Citation, Michigan State University (1955), and Honorary Doctor of Science degrees from the University of Gembloux, Belgium (1960), from North Dakota State University (1962), and from the University of Ghent, Belgium (1963).*

An inspired leader, brilliant soil scientist, and teacher in service to humanity, Dr. Kellogg's special library collection will provide a rich source of scientific knowledge for generations to come.

Dr. Mary E. Pennington (1872-1952), one of the nation's outstanding food and refrigeration scientists who was closely associated with the refrigeration industries for more than a century, received her Ph.D. from the University of Pennsylvania. A specialist in bacteriology and food science, she established the Philadelphia Clinical Laboratory in 1898 which provided services to some 400 subscribing doctors. In 1905 she was named bacteriological chemist and chief of the Food Research Laboratory of the Department of Agriculture. During World War I, she took an active part in the War Food Administration under Herbert Hoover. From 1923 to 1931 she was director of the Household Refrigeration Bureau of the National Association of Ice Industries. During her long career, Dr. Pennington was published in a number of magazines, wrote technical articles and government bulletins, and made many addresses before technical and commercial organizations on the handling, refrigeration, and distribution of perishables. A special collection of her writings was recently donated to NAL.

TECHNICAL INFORMATION SYSTEMS NOTES



A search for information in the food and agricultural sciences is done rapidly through the use of five computer retrieval systems operated at the National Agricultural Library, Beltsville, Maryland. Above is one of the computer terminals available to the public for locating materials at the library. (Photo courtesy U.S. Department of Agriculture).

ENERGY INFORMATION QUICKLY RETRIEVED

Information on energy as it relates to agriculture is now being collected and made available and made available faster and on a wider scale to aid research and extension staffs in programming activities.

A cooperative agreement between SEA's Technical Information Systems and Michigan State University provides for a continuous feed-in of energy-in-agriculture citations to the TIS computer-based bibliographic file, AGRICOLA. *Some 2,600 citations have already been added to* AGRICOLA, *which now has over 1.4 million citations from the TIS National Library collection.*

The energy-in-agriculture subfile scans private sources as well as reports of government-financed research and publications produced by State Cooperative Extension Services.

This subfile is the newest addition to other specialized subfiles of AGRICOLA *on such subjects as agricultural economics, environment, nutrition, and animal health and disease.*

PUBLICATION PRESERVED ON FILM

A modern-day library technique of putting printed material on films, called microfiche, is helping USDA agencies preserve technical and popular publications so they will be available to researchers and consumers. One of the largest preservation projects for the USDA National Agricultural Library, which is responsible for the program, has involved the Economics, Statistics, and Cooperatives Service and the microfiching of serials prepared earlier by a predecessor agency, the Economic Research Service. These serials encompass publications dealing with foreign trade, economics, and areas of public interest. Microfiche copies are being made available through the National Technical Information Service.

RESEARCHERS AT REMOTE LOCATIONS CAN GET DOCUMENTS FAST

Even though they many be stationed at locations far removed from the USDA National Agricultural Library at Beltsville, Maryland, many research scientists now can get quick delivery of scientific documents they need.

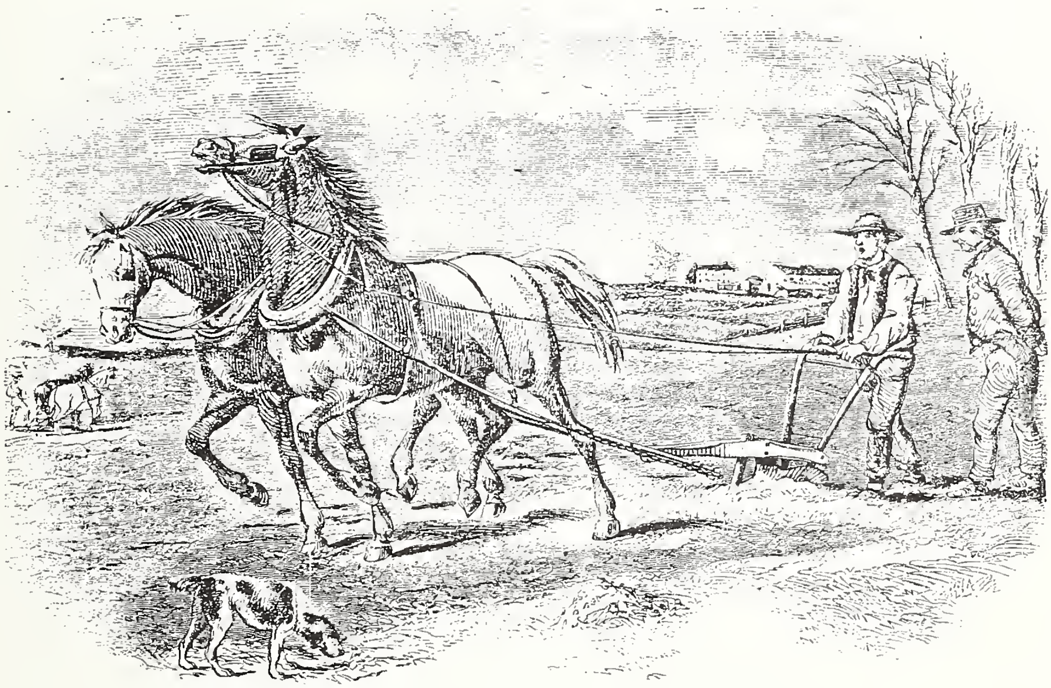
That is because of a program known as the Regional Document Delivery System. Under this system, now operating in 27 States and Puerto Rico, USDA field libraries, land grant university libraries and regional coordinating libraries give quick response to requests from local researchers to conduct searches and provide needed documents.

The system, which is operated jointly by NAL and the land-grant university libraries, is coordinated through regional NAL centers located in California, Georgia, Iowa, Minnesota, Texas, and Washington.

NEW REPORTING SYSTEM PINPOINTS STATE EXTENSION ACCOMPLISHMENTS

SEA's Technical Information Systems and Extension units are getting new and in-depth information on State program accomplishments and on the social and economic impact of Extension programs throughout the United States.

Known as the narrative accomplishment reporting system, the program electronically stores and retrieves information in areas of critical concern to Extension. One page descriptions of programs are fed into a computer based information system. Retirevals can be made on broad topics such as nautral resources, food and nutrition, agriculture, or 4-H, or on specific concepts such as crayfish, range condition, farm credit, nutrition labeling, downtown revitalization, family housing, or wood use.



("The Importance of Good Plowing" in *American Agriculturist*, April, 1863).

The Associates of the
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